For Reference

NOT TO BE TAKEN FROM THIS ROOM

For Reference

NOT TO BE TAKEN FROM THIS ROOM

Ex libris
universitatis
albertaensis

QUAECUMQUE VERA

University of Alberta
Printing Department

Digitized by the Internet Archive
in 2018 with funding from
University of Alberta Libraries

https://archive.org/details/comparativestudy00stev_0

1961(F)
#36

THE UNIVERSITY OF ALBERTA

A COMPARATIVE STUDY OF THE HIGH SCHOOL PHYSICAL SCIENCE PROGRAMS FOR TWO SCHOOL YEARS 1935-36 AND 1959-60

A THESIS
SUBMITTED TO
THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF EDUCATION

DIVISION OF SECONDARY EDUCATION

by

STEVE W. RADOMSKY
EDMONTON, ALBERTA
JUNE, 1961

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "A Comparative Study of the High School Physical Science Programs for Two School Years, 1935-36 and 1959-60," submitted by Steve W. Radomsky in partial fulfilment of the requirements for the degree of Master of Education.

June, 1961.

ABSTRACT OF THESIS

This survey, which compares the physical science programs in Alberta high schools for the two years 1935-36 and 1959-60, was undertaken against the background of current criticism of our high school programs. Its purpose is to establish whether or not the chemistry and physics programs in Alberta schools are below the standards of those offered some twenty-five years ago. This is done in two stages. First, the study compares the content in the courses prescribed, the laboratory work and the examinations used in 1935-36 and in 1959-60. Second, it discusses recommendations for revising the physical science programs.

A major finding is that the prescribed content in physics in 1959-60 was essentially the same as that prescribed in 1935-36. However, the physics program was strengthened in 1959-60 by the addition of prescribed laboratory work. More chemistry of a varied nature was prescribed in 1959-60 than in 1935-36. The emphasis on laboratory work was the same.

The 1960 departmental examinations were more representative of the course content and contained a better variety of types of questions than those of 1936.

There appears to be a serious need for the revision of the high school physical science curricula in Alberta. The material prescribed does not meet the demands of the present social and economic situation in that the most modern concepts in chemistry

and physics are not given adequate treatment. It is suggested that a periodic review of the science curricula be established and a careful study of new experimental programs be carried out frequently and evaluated for future revisions of science courses.

ACKNOWLEDGMENTS

I wish to express my grateful appreciation to the members of my committee, Mr. M. N. Nay (adviser), Dr. H. S. Baker and Mr. C. Hampson, for their patient guidance and their critical and valuable observations. I also wish to acknowledge the kind cooperation of Mr. A. B. Evenson and his staff of the Department of Education in helping me with my research work.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	ORIGIN, NEED AND PURPOSE OF STUDY	1
II.	METHODS AND PROCEDURES USED IN CARRYING OUT THE STUDY	9
III.	DETAILS OF THE CONTENT IN THE COURSES PRESCRIBED.	14
IV.	A COMPARISON OF PRESCRIBED LABORATORY WORK. . . .	35
V.	A COMPARISON OF DEPARTMENTAL EXAMINATIONS USED IN 1936 and 1960	38
VI.	DISCUSSION OF OBJECTIVES AND REGULATIONS.	44
VII.	DISCUSSION OF RECOMMENDATIONS FOR REVISING THE HIGH SCHOOL CHEMISTRY CURRICULUM	52
VIII.	DISCUSSION OF RECOMMENDATIONS FOR REVISING THE HIGH SCHOOL PHYSICS CURRICULUM	57
IX.	DISCUSSION OF THE ROLE OF LABORATORY WORK IN THE SCIENCE.	61
X.	RECAPITULATION AND RECOMMENDATIONS.	65
	BIBLIOGRAPHY.	69
	APPENDIX A. REGULATIONS OF THE DEPARTMENT OF EDUCATION	72
	APPENDIX B. OUTLINES OF REQUIREMENTS	81
	APPENDIX C. PRESCRIBED LABORATORY EXERCISES . .	104
	APPENDIX D. DEPARTMENTAL EXAMINATIONS.	114

LIST OF TABLES

TABLE PAGE

I. DETAILS OF CHEMISTRY COURSES 14-19

II. DETAILS OF PHYSICS COURSES 23-32

CHAPTER I

ORIGIN, NEED AND PURPOSE OF STUDY

During the last few years education in Alberta has been severely critized by influential spokesmen. This criticism has come from various sources ranging from educational experts to laymen. The vast majority of publicity has appeared to be directed at the Alberta school curriculum. Particular dissatisfaction has been shown with the enterprise and the teaching of the 3 R's.

Reporting on Education Week, the editor of the Edmonton Journal wrote the following on March 9, 1960:

> Until we return to the sound methods of education which were so foolishly abandoned in this province and elsewhere in favor of so-called "progressivism", we shall continue to be plagued by schools which are not allowed to teach, and afflicted with teachers whose own elementary schooling was quite inadequate for the teaching profession.
>
> The best way to observe Education Week is for those in authority to realize the grave deficiencies in our schools today and then set out to correct them.[1]

The Department of Education felt the pressure of public opinion. In 1957, the Minister of Education set up an Advisory Committee on Education. This committee was broadly representative of the many interests and groups within the province. Despite the valuable

---

[1] Report on Education Week. Edmonton Journal Editorial March 9, 1960.

contributions of the Advisory Committee, our government officials realized that the problems were so complex as to require an extensive and disciplined study. On December 31, 1957, the Alberta Royal Commission on Education was established by an Order-in-Council, approved and ordered by The Honourable John J. Bowlen, Lieutenant-Governor.

The Commission's report indicates the following reasons for the enlarged public attention:

> Nevertheless there are some very real reasons for enlarged public attention at this time. One of these is virtually complete implementation of a policy of general education for all. Parents are genuinely concerned for their children because they perceive the dividends paid by education in vocational choice and success. Business and industrial groups are concerned because of the close relationship between certain aspects of the curriculum and the competency of employees. Professional and university groups are concerned because of the nature of the high school program as prerequisite to further professional or academic study. Religious groups are concerned because of the degree to which variously approved credal or moral concepts are or are not represented in the philosophy and curriculum of the schools. Needless to say, some of the interests are altruistic and public spirited; some may be selfish and sectional.
>
> Further causes are not far to seek: the rapid growth and shift of population, increasing industrialization and job specialization, changing social patterns, mounting costs of school buildings, equipment, and teaching services. These and other developments have inevitably challenged various kinds of public interest and criticism.[2]

---

[2] Province of Alberta, Report of the Royal Commission on Education, Queen's Printer, Edmonton, 1959. p. 3.

Some general criticisms brought out by the Royal Commission which may be considered as directed at the Alberta science program are:

A. Curriculum

1. The standards are too low.

2. The level of expectation and the challenge presented by the schools are too low.

3. Text-books are inaccurate and do not parallel or satisfy specific courses.

4. Courses are not sufficiently varied as to be both suitable and challenging to differing levels of ability.

5. The gifted have been particularly neglected with regard to both programs and acceleration.

6. Grade XII graduates find it difficult or are unable to gain admission to universities outside of Alberta.

7. Preparation of matriculants for the University of Alberta is inadequate.

B. Examinations

1. The "curve" systems of marking should be replaced by "absolute" standards.

2. Departmental examinations should be extended to grades X and XI.

3. Children are given little experience in writing examinations, and the examinations which are written are of the short answer, multiple choice, "objective" type.

Since this is a comparative study of the high school physical science program for the years 1935-36 and 1959-60, it would be instructive to know what the state of education in Alberta was in the mid-thirties. It is difficult to establish whether great public concern over educational matters existed in 1935 but the officials of the Department of Education were certainly aware of the fact that the system was in need of revision. This realization was reflected in the following statement made by the Minister of Education in 1935:

> For the past thirty years the Province of Alberta has been operating a system of school administration inherited from the old Territorial regime. From time to time improvements have been made in this system but its main features remain as they were in 1905. It has accordingly become very clear to those who are charged with the responsibility of administering Alberta's Schools that if these schools are to continue to serve the purpose for which they were established, to say nothing of further progress, a new chapter in Alberta's educational history must now be written. The strain of these depression years has revealed dangerous flaws and radical defects in the educational structure which cannot be removed merely by patching. The thirty-years-old structure must be rebuilt.[3]

The Minister of Education saw the need, also, for larger units and for adequate instruction beyond the Grade VIII level in rural districts.

---

[3] Province of Alberta, What is and What might be in Rural Education in Alberta. Published by authority of The Minister of Education. King's Printer, 1935. p. 3.

> In at least 50% of our ungraded schools there is no way by which boys and girls who have completed Grade VIII can have access to high school instruction. Many of these schools are permitted by the local inspector to give instruction in Grade IX, when the teacher is competent and the enrolment is not too large; but very few schools of this type can offer such instruction without detriment to the interests of the elementary pupils, for whom, primarily, the schools were established.
>
> The plain fact is, therefore, that for a large number - too large a number - of our country boys and girls, schooling must cease with the completion of Grade VIII.[4]

In 1935 the Minister of Education recommended the establishment of larger units, claiming that the small unit was neither efficient nor economical. The Minister saw in this move the possibility of greater educational opportunity for children in the rural areas.

It must be borne in mind that 30.7% of the urban population attended urban schools, while only 18.4% of the rural population attended rural schools.

Also, the Minister of Education saw the need for a diversified education which could not be provided by the small units.

> The high school group exhibits a wide range of differing interests, aptitudes, and personalities. For the great majority of this group formal education will end in the secondary school. What is required, therefore, is a diversified high school programme, suited to the needs of this majority.[5]

---

[4] Ibid, p. 3.

[5] Ibid, p. 5.

By the end of the depression changes in the educational system became evident. Large administrative units had been set up and a more diversified program established for the students. Also at the beginning of World War II a new philosophy of education had taken root. Up to 1935-36 education was basically of the academic nature. The prime purpose of high school education was university entrance. However, in the new philosophy a general education was deemed necessary for all.

The change in educational policy coupled with the population and economic growth in the province has resulted in some interesting trends in school population and costs. In 1935-36, education cost the tax-payer $9,118,700 to keep 167,193 pupils in school. In 1959-60 the cost was $78,848,000 to keep 216,554 pupils in school. The average cost of education per pupil year rose from $54.54 in 1935-36 to $301.46 in 1959-60.

It is also interesting to note that in 1935-36, the grade XII population was approximately 11% of the grade I population and in 1959-60 the grade XII population was approximately 32% of the grade I population. From this one can infer that the retention of students in school at the grade XII level in 1959-60 was about three times as great as in 1935-36.

In the light of the soaring costs of education, it appears that the public has cause for concern. The tax-payer, no doubt, would like to know how his money is spent and whether he is getting 'his money's worth'. It would appear that the simplest way the tax-payer might

arrive at some conclusion would be to compare the kind and cost of education of twenty-five years ago with that of today.

Science education has not been exempt from criticism. The Alberta high school science program has been referred to as "diluted" and below the standard offered some twenty-five years ago.

It has recently been asserted, for example, that the curricula do not meet the educational need.

> With the current explosion in scientific expansion there is a great need for more and better educated chemists, but current curricula in universities and high schools are not measuring up to this need.
>
> Today's chemistry courses in universities and science and mathematics courses in high schools are providing for neither current nor future needs.
>
> There must be more and better mathematics, physics and chemistry taught in schools, and the teaching must be better than it now is. Moreover, courses of study in these subjects cry out for revision - topics should be carefully selected and arranged in more logical sequence.[6]

Specifically, chemistry and physics in grade XII attracted little criticism before the Commission, and even merited some commendation. However, the physics and chemistry taught in grades X and XI (Physical Science 10 and 20) were strongly attacked.

> While it has not been shown that these courses in physical science caused inferior performance in grade XII, unquestionably they have required extensive supplementing in order to make them challenging to capable science students. Recognition of this

---

[6] L. H. Cragg, A Report to the Chemical Institute of Canada. Edmonton Journal, June 17, 1961.

> fact has already prompted their revision. Shortly, science in grades X and XI will revert to physics and chemistry. In the immediate future, the basic matriculation pattern in science will comprise physics and chemistry throughout grades X, XI and XII.[7]

It is evident, from the above, that Alberta high school curricula have been severely criticized currently as well as some twenty-five years ago. Since the major portion of this criticism has come from experts in education, one can neither take it lightly nor blame it on the soaring costs of education. Education is a reflection of society, therefore, it is important to pause frequently to evaluate the standards in order to see what changes have taken place and whether these changes are desirable.

Of the two periods chosen for the present study, one of them, 1935-36, came at the turning point in educational change in the province. The other, 1959-60, came at a time when considerable public attention was focussed on the state of education.

---

[7] Province of Alberta, Report of the Royal Commission on Education, Queen's Printer, Edmonton, 1959. p. 113.

CHAPTER II

METHODS AND PROCEDURES USED IN CARRYING OUT THE STUDY

This is not an experimental survey. It is intended to be a critical study of the Physics and Chemistry courses in Alberta High Schools in the years 1935-36 and 1959=60.

Sources of Information

In order to do this survey the following documents and literature were examined:

1. Departmental regulations and bulletins for 1935-36 and 1959-60.
2. Handbooks for Secondary Schools for 1935-36 and 1959-60.
3. Curriculum guides for 1935-36 and 1959-60.
4. Authorized text-books and laboratory manuals for 1935-36:

   (a) Physics I

   Merchant and Chant: *Ontario School Physics (Revised Edition)*, Copp Clark Co.

   (b) Chemistry I

   Cornish: Chemistry: *A Text-book for High Schools*, MacMillan Co.

   Cornish and Smith: *A Laboratory Manual in Chemistry*.

   (c) Physics II

   Merchant, Chant and Cline: *Mechanics, An Elementary Text-book*, Copp Clark Co.

(d) Chemistry II

Littler: Elementary Chemistry, Book II

Littler: Laboratory Manual to accompany Book II.

5. Authorized text-books and laboratory manuals for 1959-60.

(a) Science 10

(i) Hogg, Cross and Little: Physical Sciences for Canadian Schools, D. Van Nostrand Co. (Canada) Ltd.

(ii) Croal et al: Chemistry for Secondary Schools (Advanced Edition), Copp Clark Co. Ltd.

(iii) Pickard and Radomsky: Introductory Chemistry and Physics, D. Van Nostrand Co. (Canada), Ltd.

(b) Science 20

(i) Eubank, Ramsay and Rickard: Physics for Secondary Schools (Alberta Edition), The MacMillan Co. of Canada Ltd.

(ii) Croal et al: Chemistry for Secondary Schools (Advanced Edition), Copp Clark Co. Ltd.

(c) Physics 30

Littler: Elementary Physics, Clark, Irwin and Co., Ltd.

Laboratory Exercises in Physics 30, Department of Education 1957.

(d) Chemistry 30

Croal et al: Chemistry for Secondary Schools (Advanced Edition), Copp Clark Co. Ltd.

Laboratory Exercises in Chemistry 30, Department of Education.

6. Departmental examinations for 1935-36 and 1959-60.
7. Official tabulations of results by the Department of Education.
8. Current publications.
9. Current reports.

The submissions to and recommendations by the Cameron Commission were, in particular, closely studied since this is believed to be one of the most extensive and disciplined studies carried out in Alberta on educational matters.

Information Used in the Study.

The above were examined primarily for the following information:

1. Prerequisites in science courses.
2. Instruction time.
3. Requirements for Junior and Senior matriculation certificates.
4. Science requirements for Normal School and University entrance.
5. Specific objectives in the teaching of science.
6. Prescribed concepts and principles.
7. Laboratory requirements.
8. Types of examinations.
9. Distribution of examination results.
10. Current criticisms and recommendations.

Limitations of the Study

1. Although a number of changes in the science curricula were made between the years 1936 and 1959, no attempt was made to investigate these changes.
2. In a study of this nature an evaluation of the degree to which the concepts and principles in the prescribed physics and chemistry programs were developed in the classrooms would be worthwhile. Since it is not feasible to make a survey of the teaching methods used in 1935-36 and 1959-60, this study is limited to the prescribed programs.
3. This study is limited to the programs in Alberta schools. No attempt was made to compare the Alberta programs with those of other provinces or countries.
4. It was found difficult and at times impossible to distinguish between the concepts of physics and those of chemistry.
5. No attempt was made to compare the general aims and objectives of high school teaching in 1959-60 with those in 1935-36. Only a brief survey of the immediate aims in the curriculum guides and text-books pertinent to the teaching of science was made.
6. It was found difficult to establish the extent to which the concepts and principles of chemistry and physics were actually taught by the laboratory method. This survey is restricted to:

(a) the prescribed laboratory experiments.

(b) the extent to which examinations were based on laboratory work.

7. A brief survey of the examination papers was made to determine:

(a) the type of examinations.

(b) the concepts which they attempted to examine.

Since departmental examinations were used at the grades X and XI levels in 1936 and were not in 1960, this survey is limited to the comparison of examinations written at the grade XII level.

8. It was impossible to compare the sciences taught at different grade levels. In 1935-36, physics was offered in grade X and chemistry in grade XI. In 1959-60 a chemistry-physics combination was offered both in grade X and XI. As a result, it was found necessary to confine this survey to a combined study of chemistry and physics throughout the three high school grades.

9. During the year 1959-60, the science 10 course was in the process of being changed. While some schools used the Physical Sciences for Canadian Schools as the official text-book, others experimented with a proposed new course and used outlines of the new text, Introductory Chemistry and Physics. This made a study of both programs necessary. However, it was found that the change was essentially a reorganization of content. Since no major additions in content were made, this change did not appear to present any difficulty.

CHAPTER III

DETAILS OF THE CONTENT IN THE COURSES PRESCRIBED

The tables below give a detailed analysis of the text-book content prescribed in handbooks and course outlines.

TABLE I

DETAILS OF CHEMISTRY COURSES

Contents	Prescribed in 1935-36	Prescribed in 1959-60
Field of Chemistry	Included	Included
Importance of Science	"	"
Physical Change	"	"
Chemical Change	"	"
Chemical Union	"	"
Decomposition	"	"
Elements	"	"
Compounds	"	"
Mixtures	"	"
Study of Elements	"	"
free	"	"
combined	"	"
number	"	"
distribution	"	"
relative importance	"	"
classification	"	"
metals	"	"
non-metals	"	"
preparation	"	"
physical properties	"	"
chemical properties	"	"
occurrence	"	"
natural and economic importance	"	"

TABLE I (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
Elements prescribed for study		
hydrogen	Included	Included
oxygen	"	"
nitrogen	"	"
carbon	"	"
sulphur	"	"
chlorine	"	"
potassium	"	"
sodium	"	"
calcium	"	"
Air		
composition	"	"
importance	"	"
Water		
analysis	"	"
synthesis	"	"
sources	"	"
impurities	"	"
purification	"	"
crystallization	"	"
efflorescence	"	"
deliquescence	"	"
dehydration	"	"
Solutions		
liquid	"	"
gaseous	"	"
properties	"	"
unsaturated	"	"
supersaturated	"	"
solubility curve	"	"
effect of change in temperature	"	"
precipitation	"	"
crystallization	"	"
filtration	"	"
Combustion		
ordinary	"	"
slow	"	"
spontaneous	"	"
ignition	"	"
temperature	"	"
flames of candle	"	"
Bunsen burner	"	"

TABLE I (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
oxidation	Included	Included
reduction	"	"
Oxides	"	"
Acids	"	"
Bases	"	"
Salts	"	"
Neutralization	"	"
Law of Conservation of Mass	"	"
Laws of Definite and Multiple Proportions	"	"
Boyle's Law	"	"
Charles' Law	"	"
Law of Combining Weights	"	"
Gay Lussac's Law of Volumes	"	"
Atomic Theory and Structure	"	"
Molecular Theory	"	"
Avogadro's Hypothesis	"	"
Ionization	"	"
Value of Theories in Explaining Facts and Laws and in Discovering New Truths	"	"
Valency	"	"
Formulae	"	"
Nomenclature	"	"
Equations	"	"
Calculations	"	"
atomic	"	"
molecular	"	"
combining weights	"	"
Elements and their Compounds	"	"
hydrogen	"	"
helium	"	"
lithium	"	Not included
sodium	"	Included
potassium	"	"
copper	"	"
silver	"	Uses only
gold	"	" "
calcium	"	Included
strontium	"	Tests only
barium	"	Tests and Compounds only
radium	"	Not included
magnesium	"	Included
zinc	"	"

TABLE I (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
mercury	Included	Oxide only
boron	"	As used in test only
aluminum	"	Included
carbon	"	"
silicon	"	"
tin	"	Uses only
lead	"	Tetraethyl lead only
nitrogen	"	Included
phosphorus	"	"
arsenic	"	Chlorides only
antimony	"	" "
bismuth	"	Not included
chromium	"	Uses only
tungsten	"	Uses only
oxygen	"	Included
sulphur	"	"
manganese	"	"
fluorine	"	"
chlorine	"	"
bromine	"	"
iodine	"	"
iron	"	"
cobalt	"	Not included
nickel	"	As catalyst only
platinum	"	Uses only
Elements studied under		
occurrence	"	Included
metallurgy	"	"
mineralogy	"	"
group characteristic (Periodic Law)	"	"
economic uses	"	"
processes of manufacture	"	"
Law of Definite and Multiple Proportions	"	"
Boyle's Law	"	"
Charles' Law	"	"
Gay Lussac's Law of Volumes	"	"
Dulong and Petit's Law	"	Not included
Raoult's Law	"	" "
Periodic Law	"	Included
Avogadro's Hypothesis	"	"

TABLE I (continued)

content	Prescribed in 1935-36	Prescribed in 1959-60
Molecular Theory	Included	Included
Atomic Theory	"	"
Ionization	"	"
Electrons	"	"
Acids	"	"
Bases	"	"
Salts	"	"
Neutralization	"	"
Normal Solutions	"	"
Organic Chemistry	"	"
Carbohydrides (hydrocarbons)	"	"
Carbohydrates	"	"
Alcohols	"	"
Acids	"	"
Esters	"	"
Fats	"	"
Soaps	"	"
Explosives	"	"
Poisonous gases	"	"
Qualitative Analysis of:		
Cations	"	"
Hg^+	"	"
Ag^+	"	"
Pb^+	"	"
Cu^+	"	"
Sn^{++}	"	Not included
Al^{+++}	"	Included
Zn^{++}	"	Not included
Fe^{+++}	"	Included
Ca^{++}	"	"
Mg^{++}	"	"
Na^+	"	"
K^+	"	"
NH_4^+	"	"
Hg^{++}	"	"
Fe^{++}	"	"
Anions		
Cl^-	"	"
S^{--}	"	"
SO_3^{--}	"	"
PO_4^{---}	"	"

TABLE I (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
CO_3^{--}	Included	Included
NO_3^-	"	"
SO_4^{--}	"	"
OH^-	"	"
Sublimation	"	"
Hydrogenation	"	"
Electrovalence	"	"
Covalence	"	"
Henry's Law	"	"
Oxidation and Reduction Based on Electron Theory	Not included	"
Spectroscope and Its Uses	" "	"
Thermit Process	" "	"
Case-hardening of Steel	" "	"
Bemberg Process for Making Rayon	" "	"
Synthetic Materials	" "	"
Polymers	" "	"
Ethers	" "	"
Aldehydes	" "	"
Ketones	" "	"
Anti-knock Gasoline	" "	"
Chemistry of Foods	" "	"
digestion	" "	"
absorption	" "	"
metabolism	" "	"
sugars	" "	"
polysaccharides	" "	"
Rayon	" "	"
Celanese	" "	"
Proteins	" "	"
Amino acids	" "	"
Test for Proteins	" "	"
Denaturation	" "	"
Vitamins	" "	"
Hormones	" "	"
Chemotherapy	" "	"
salvarsan	" "	"
sulphanilamide	" "	"
penicillin and other antibiotics	" "	"

A study of Table I reveals the following information:

1. Every concept and principle prescribed in Chemistry I, at the Grade XI level, in the year 1935-36 was also prescribed in the year 1959-60 although not necessarily at the same grade level.
2. The major portion of the content prescribed in Chemistry 2 (1935-36) consisted of the study of elements and their compounds under the following headings:
   - (a) Occurrence
   - (b) Metallurgy
   - (c) Mineralogy
   - (d) Properties
   - (e) Tests
   - (f) Economic uses

   Thirty-nine elements were listed for study under the above mentioned topics. Only nineteen of these elements were prescribed for detailed study in the year 1959-60. Of the remaining twenty elements sixteen were studied in part only and four were omitted.
3. All the laws, hypotheses and theories prescribed in the year 1935-36 were also prescribed in the year 1959-60 except:
   - (a) Dulong and Petit's Law
   - (b) Le Chatelier's Law.
   - (c) Molecular depression of freezing point and determination of molecular weight.

(d) Raoult's Law.

(e) Law of mass action.

Henry's law was prescribed in the year 1959-60, but not in the year 1935-36.

4. The Periodic Table was expanded and studied in more detail in the year 1959-60.
   (a) Ten new elements were added.
   (b) Transition elements were shown as a separate group.
   (c) Valence was expanded with respect to hydrogen.
   (d) The position of metals and non-metals was established more clearly.
   (e) The position of the most metallic element and the most non-metallic element was clearly defined.
   (f) The gradation of chemical properties of elements was shown horizontally and vertically.
   (g) More stress on atomic structure was placed in the study of the Periodic Table.
5. The Theory of Ionization was expanded and studied in more detail in 1959-60. More use of it was made in the explanation of chemical reactions.
6. More emphasis was placed on electrovalence and covalence in 1959-60.
7. More emphasis was placed on problem solving in 1959-60.
8. The section on qualitative analysis of cations and anions was the same in the year 1959-60 as in the year 1935-36.

9. The section on Organic Chemistry was expanded and given more emphasis in the year 1959-60.

10. The following major topics were prescribed in the year 1959-60, but not in 1935-36:

    (a) Petroleum industry.

    (b) Synthetic materials.

    (c) Polymers.

    (d) Chemistry of foods.

    (e) Chemotherapy.

    (f) Treatment of steel and the making of alloys.

From the above it is evident that more chemistry of a varied nature was prescribed in 1959-60 than in 1935-36.

Table II shows the topics which were prescribed in Physics in the years 1935-36 and 1959-60.

TABLE II

DETAILS OF PHYSICS COURSES

Content	Prescribed in 1935-36	Prescribed in 1959-60
Molecular Theory of the Composition of Matter	Included	Included
Molecular forces	"	"
Cohesion	"	"
Adhesion	"	"
Surface tension	"	"
Capillarity	"	"
Molecular motions explaining phenomena of heat expansion	"	"
Gas pressure	"	"
Diffusion	"	"
Osmosis	"	"
Heat	"	"
Nature and sources	"	"
Expansion of solids	"	"
Increase in length	"	"
Increase in diameter	"	"
Coefficient of expansion	"	"
Unequal expansion	"	"
Practical applications	"	"
Expansion of liquids	"	"
Coefficient of expansion	"	"
Practical applications	"	"
Construction of thermometer	"	"
Graduation of thermometer	"	"
Fahrenheit scales	"	"
Centigrade scales	"	"
Maximum density of water	"	"
Natural importance	"	"
Expansion of gases	"	"
Equal expansion of all gases	"	"
Charles' Law	"	"

TABLE II (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
Heat transmission	Included	Not included
conduction	"	" "
convection	"	" "
radiation	"	" "
practical applications, heating and ventilating systems	"	" "
Heat measurements	"	Included
calorie	"	"
British Thermal Unit	"	"
Thermal capacity	"	"
Specific heat	"	"
Practical applications	"	"
Change of state	"	"
Solids to liquids	"	"
Liquids to solids	"	"
Freezing point	"	"
Melting point	"	"
Effect of pressure	"	"
Substances in solution	"	"
Change of volume	"	"
Heat of fusion	"	"
Freezing mixtures	"	"
Practical applications	"	"
Liquids to gases	"	"
Gases to liquids	"	"
Evaporation	"	"
Conditions affecting the rate of evaporation	"	"
Heat absorbed	"	"
Dew point	"	Not included
Humidity	"	" "
Vapor pressure	"	" "
Boiling point	"	Included
Effect of pressure on b.p.	"	"
Effect of altitude on b.p.	"	"
Effect of solutes on b.p.	"	"
Distillation	"	"
Practical applications	"	"
Cooling by evaporation	"	"
Artificial cooling	"	"
Hydrometer	"	"

TABLE II (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
Wave Motion	Included	Included
Energy transmission	"	"
Direct contact	"	"
Conduction	"	Not included
Convection	"	" "
Currents	"	" "
Characteristics of wave motion	"	Included
Nodes of waves	"	"
Transverse waves	"	"
Longitudinal waves	"	"
Wave length	"	"
Amplitude	"	"
Frequency	"	"
Relation between velocity, wave length and frequency	"	"
Reflection of waves	"	"
Nodes and loops	"	"
Energy transmitted by wave motion	"	"
sound	"	"
light	"	"
electricity	"	Not included
wireless telegraphy	"	" "
radiophone	"	" "
media of transmission	"	Included
Sound		
Production	"	"
Transmission	"	"
Velocity	"	"
Reflection	"	"
Echo	"	"
Relation of velocity to medium	"	"
Intensity	"	"
Relation of density of medium	"	"
Amplitude of vibration	"	"
Distance of sounding body	"	"
Musical tone	"	"
characteristics	"	"
intensity	"	"
pitch	"	"
quality	"	"
factors on which each depends	"	"

TABLE II (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
Musical instruments	Included	Included
production of musical tone	"	"
change in pitch	"	"
stringed instruments	"	"
wind instruments	"	Not included
phonograph	"	" "
Light		
Transmission	"	Included
Pin-hole camera	"	"
Shadows	"	"
Intensity of illumination	"	"
Illuminating power	"	"
Law of inverse squares	"	"
Photometry	"	"
Practical applications	"	"
Reflection of light	"	"
plane mirrors	"	"
laws of reflection	"	"
position of images	"	"
characteristics of images	"	"
inclined mirrors	"	"
parallel mirrors	"	"
curved mirrors	"	"
convex mirrors	"	"
concave mirrors	"	"
parabolic mirrors	"	"
principal axis	"	"
radius of curvature	"	"
principal focus	"	"
real and virtual images	"	"
relative position and magnitude of object and image	"	"
practical uses	"	"
Refraction of light	"	"
nature of refraction	"	"
cause of refraction	"	"
laws of refraction	"	"
index of refraction	"	"
refraction phenomena	"	"
plate glass	"	"
prisms	"	"
lens	"	"

TABLE II (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
total reflection	Included	Included
Lenses	"	"
concave and convex	"	"
principal focus	"	"
focal length	"	"
power	"	"
conjugate foci	"	"
images	"	"
application	"	"
Lunfer prisms	"	Not included
magnifying glasses	"	Included
spectacles	"	"
camera	"	"
projection lantern	"	"
Color	"	"
production of spectrum	"	"
complementary colors	"	"
rainbow	"	"
color of objects	"	"
mixing paints	"	"
Magnetism	"	Not included
Natural and artificial magnets	"	" "
Magnetic substances	"	" "
Polarity	"	" "
Laws of attraction and repulsion	"	" "
Induction	"	" "
Field of force	"	" "
Magnetic permeability	"	" "
Shielding	"	" "
Earth's magnetism	"	" "
Demonstration of earth's polarity and inductive action	"	" "
Declination	"	" "
Inclination	"	" "
Compass	"	" "
Current Electricity	"	Included
Voltaic cell	"	Not included
construction	"	" "
source of energy	"	" "
local action	"	" "
polarization	"	" "

TABLE II (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
detection of current	Included	Included
methods of preventing polarization and local action	"	Not included
a few common cells	"	" "
Electric units	"	Included
ampere	"	"
volt	"	"
ohm	"	"
Ohm's Law	"	"
grouping of cells	"	"
Chemical and magnetic effects	"	"
electrolysis of water	"	"
electroplating	"	"
magnetic field about a conductor	"	"
electromagnet	"	"
function of helix and core	"	"
conditions determining strength of electromagnets	"	"
electric bell	"	Not included
telegraph	"	" "
lifting magnets	"	" "
galvanometers	"	Included
Induced current	"	"
production of Lenz' Law	"	"
alternating currents	"	"
Units of Measurement	"	"
Time	"	"
Mass	"	"
Length	"	"
Area	"	"
Volume	"	"
Methods of measuring	"	"
Motion	"	"
Definition	"	"
Velocity	"	"
Parallelogram of velocities	"	"
Resolution of displacement	"	"
Momentum	"	"
Relation of momentum to mass and velocity	"	"
Change of momentum	"	"

TABLE II (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
Relation of force and time	Included	Included
Newton's second law of motion	"	"
Transference and conservation of momentum	"	"
Force	"	"
Gravity and absolute units	"	"
Mass and weight	"	"
Comparison of masses	"	"
Inertia	"	"
Newton's first law	"	"
Newton's third law	"	"
Centrifugal and centripetal forces	"	Not included
Centrifuge	"	" "
Babcock's milk tester	"	" "
Cream separator	"	" "
Composition and resolution of forces	"	Included
Parallelogram of forces	"	"
Triangle of forces	"	"
Moment of a force	"	"
Resultant of parallel forces	"	"
Couple	"	"
Equilibrium of a rigid body	"	"
Sliding friction	"	"
Rolling friction	"	"
Coefficient of friction	"	"
Laws of friction	"	"
Centre of gravity	"	"
Condition of equilibrium	"	"
Three states of equilibrium	"	Not included
Principle of universal gravitation	"	Included
Energy	"	"
Units of energy	"	"
Units of power	"	"
Heat units	"	"
Electrical units	"	"
Mechanical units	"	"
Law of conservation of energy	"	"
Relation of energy and power	"	"
Power development	"	"
Power transmission	"	"

TABLE II (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
Water power	Included	Not included
Water wheels	"	" "
Turbines	"	" "
Steam turbines	"	" "
Steam engines	"	" "
Gasoline engines	"	" "
Windmills	"	" "
Transformation of mechanical to electrical energy	"	Included
Use of electrical energy	"	"
Machines		
Levers	"	"
Pulley	"	"
Wheel and axle	"	"
Inclined plane	"	"
Wedge	"	"
Screw	"	"
Differential pulley	"	Not included
Differential wheel and axle	"	" "
Automobile transmission	"	" "
Mechanics of Fluids	"	Included
Pressure of fluids at rest	"	"
Pressure proportional to depth and density	"	"
Pressure independent of shape of containing vessel	"	"
Pressure gauge	"	"
Calculation of pressure on horizontal, vertical and inclined surfaces	"	Not included
Buoyancy	"	Included
Archimedes' principle	"	"
Density	"	"
Specific gravity	"	"
Methods of determining specific gravity of solids and liquids	"	"
Pressure on surfaces of water currents and winds due to their rate of flow	"	Principle only not mathematical solutions
Pressure of air	"	Included

TABLE II (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
Torricelli's experiment	Included	Included
Cistern barometer	"	"
Aneroid barometer	"	"
Determination of heights by barometer	"	"
Buoyancy of gases	"	"
Surface tension	"	"
Laws of capillarity	"	"
Applications of capillarity	"	"
Flow of liquids	"	"
Torricelli's law	"	Not included
rate of flow of a liquid	"	" "
energy of a liquid in motion	"	" "
Bernoulli's principle	"	Included
Venturi water meter	"	"
jet pump	"	"
Bunsen's filter pump	"	Not included
atomizer	"	Included
Kinetic Theory of Gases	"	"
Boyle's Law	"	"
Charles' Law	"	"
Diffusion	"	"
Expansive pressure	"	"
Calculation of rate of motion of molecules of gases	"	Not included
Machines	"	Included
Lift pump	"	Not included
Force pump	"	" "
Hydraulic press	"	Included
Siphon	"	"
Geryk pump	"	Not included
Air pump	"	" "
Mercury air pump	"	" "
Condensation vacuum pump	"	" "
Air compressors	"	" "
Air brakes	"	" "
Pneumatic caisson	"	" "
Pneumatic hammer	"	" "
Pneumatic drill	"	" "

TABLE II (continued)

Content	Prescribed in 1935-36	Prescribed in 1959-60
Light		
Theories of light	Not included	Included
Newton's Emission or Corpuscular Theory	" "	"
Huygen's Wave Theory	" "	"
Planck's Quantum Theory	" "	"
Beyond the Visible Spectrum	" "	"
Spectrum analysis	" "	"
Color printing	" "	"
Velocity of light	" "	"
Romer's method using successive eclipses of moons of Jupiter	" "	"
Fizeau-toothed wheel	" "	"
Michelson's rotating mirror	" "	"
Spectroscope	" "	"
Kinds of spectra	" "	"
Solar spectrum	" "	"
The eye	" "	"
Microscope	" "	"
Telescope	" "	"
Sound		
Transverse vibrations	" "	"
Longitudinal vibrations	" "	"
Mathematic calculations on vibrating strings	" "	"
open and closed tube vibrations	" "	"
organ pipes	" "	"
overtones	" "	"
sympathetic vibrations	" "	"
Beats	" "	"

1. The following concepts and principles, listed as not included under the Physics 1 section, were prescribed in the year 1959-60 at a lower grade level:

(a) Heat transmission-conduction, convection, radiation and practical applications prescribed in Unit IV at the grade IX level.

(b) Humidity and dew point in Unit II at the grade VIII level.

(c) Conduction, convection and currents in Unit IV at the grade IX level.

(d) Electricity introduced in Unit IV at the grade VIII level and studied in detail at the grade XII level.

(e) Magnetism (all concepts listed) in Unit IV at the grade VIII level.

(f) Voltaic cell in Unit IV at the grade VIII level.

(g) Electric bell, telegraph and lifting magnets in Unit IV at the grade VIII level.

2. The following concepts were prescribed in 1935-36 but not in 1959-60:

   (a) vapor pressure
   (b) radiophone
   (c) wireless telegraphy
   (d) wind instruments
   (e) phonograph
   (f) Lunfer prisms
   (g) Common cells, local action and polarization.

3. More emphasis has been placed on mathematical solutions of problems in 1959-60. Students were expected to do all exercises at the end of each chapter.

4. No laboratory work was prescribed in Physics 1 in the year 1935-36. Laboratory exercises were obligatory in Physics at the grade X and the grade XI level in 1959-60. Numerous exercises are listed in the text-books at the end of each unit. Students were obligated to spend one period a week on individual or small group experiments.

5. (a) The major topics prescribed at the grade X level in 1935-36 were molecular theory, heat, w ave motion, sound, light, magnetism and electricity.

   (b) The major topics prescribed at the grade X and XI levels in 1959-60 were molecular theory, heat, sound, mechanics, light and measurement.

   (c) Only mechanics was prescribed at the grade XII level in 1935-36.

   (d) The three major topics prescribed at the grade XII level in 1959-60 were mechanics, heat and electricity.

A study of the prescribed topics seems to indicate no significant difference between the amount or kind of material studied in 1935-36 and 1959-60. In 1935-36 the major portion of the prescribed content was of a descriptive nature. In 1959-60 there was an apparent shift from the descriptive type of science to problem solving and laboratory work. This appears to be in accord with the major objectives of science teaching in 1959-60.

CHAPTER IV

A COMPARISON OF PRESCRIBED LABORATORY WORK

In 1935-36 a Laboratory Manual by Cornish and Smith was prescribed for Chemistry 1 in which were outlined 37 experiments. No mention was made in the Handbook as to the number of experiments to be performed by the students or the time allotted to laboratory work.

Laboratory work in Chemistry 2 (1935-36) was stressed. Chemistry 2 could be offered only in schools where the instructor held at least standing in Chemistry 2 or its equivalent, and where the laboratory equipment was adequate for performing all the prescribed experiments. Three experiments were to be treated as demonstrations, three were to be demonstrated by the teacher or performed by the students, and twenty-four were required for all pupils. The time suggested for this laboratory work was approximately 30 periods.

In 1935-36, no laboratory manual was prescribed in Physics 1. In the section dealing with light, one note marked N.B. was found which read, "The course in light should be made as experimental as possible, but the use of drawings representing images with plane and curved mirrors and lenses will be found necessary for purposes of illustration." No laboratory exercises were prescribed.

In Physics 2 (1935-36) no laboratory exercises were prescribed. A number of experiments were illustrated and described in the text-book.

In 1959-60, 42 experiments in the chemistry section and 33 experiments in the physics section of the Science 10 text-book are outlined. The following statements appear in the Course Outlines: "Experimental work in this course should receive emphasis. Students should spend at least one day a week in the laboratory."

Thirty-five experiments are outlined in the physics section of Science 20. No specific experiments are outlined in the chemistry section. The following statements appear in the Course Outlines:

> Experimental work is to be considered an integral part of the course. Students should spend at least one day a week in the laboratory. Some teachers have found difficulty in supplying laboratory exercise to cover the chemistry section of Science 20. Source material for demonstrations as well as class experiments in this section of the work may be found in Experiments in Laboratory Chemistry by Croal, Couke and Louden.[8]

The chemistry section of Science 20 is highly mathematical and does not lend itself to experimental work.

The Laboratory Exercises manual in Physics 30 (1960) consists of twenty experiments, from which students are expected to perform not fewer than fourteen to be selected according to the type and quantities of equipment available. Not more than two of the listed experiments may be omitted for each of the three topics. In addition to the

---

[8] Province of Alberta, Department of Education, Course Outlines for Science 10 and Science 20, 1959-60.

experiments described in the Laboratory Exercises, the text provides ample suggestions for demonstrations.

The laboratory manual in Chemistry 30 consists of twenty exercises. Students are expected to perform not fewer than fourteen. Eleven of the fourteen are obligatory.

From the above information the following observations can be made:

1. No laboratory work was prescribed in Physics 1 or Physics 2 in 1935-36. In 1959-60, emphasis was placed on experimental work. Students were expected to spend 20% of their time on laboratory work. This is in line with current objectives of science teaching as set forth in Chapter 6.
2. There appears to be no significant difference in the number of laboratory exercises or the time allowed for laboratory work in chemistry at the grade XII level between the years 1935-36 and 1959-60. More laboratory work was prescribed in 1935-36 at the grade XI level.
3. As in 1935-36, the laboratory exercises in 1959-60 appear to follow the 'cook-book' method.

CHAPTER V

A COMPARISON OF DEPARTMENTAL EXAMINATIONS USED IN 1936 and 1960

In 1936 Departmental examinations were used in Physics 1, Chemistry 1, Physics 2 and Chemistry 2. In 1960 Departmental examinations were used in Physics 30 and Chemistry 30 only. Science 10 and Science 20 were non-departmental subjects; therefore it is necessary to limit this discussion to a comparison of the examinations at the grade XII level. The examinations in physics and chemistry administered in grade XII are given in Appendix D.

An Analysis of the Chemistry 2 Paper (1936)

1. The time allotted was 2½ hours.
2. Optional questions were given. The student was asked to write on three compulsory questions and choose five from eight additional questions.
3. No multiple-choice questions were used.
4. Ten of the fill-in-blank type of questions were asked. This comprised 10% of the total value of the paper. However, this section was optional.
5. Three essay type questions were included involving explanation, description or discussion on the part of the candidate. All three were optional. A student could complete the paper without answering a single essay type question.

6. The major portion of the paper was made up of a number of parts which could be answered in phrases or single sentences.
7. 15% of the final mark was based on laboratory work. This mark was assigned by the instructor.
8. One question, totalling 10% of the paper, was based on the writing of equations. Five equations were asked for. Since this question was listed as optional, a student could complete this paper without writing any equations.
9. Only two problems were asked for - one carrying a value of 6% and one, 4%. Since both sections were optional, a student could complete this paper without using any mathematics.
10. One compulsory question was asked on organic chemistry. This was evaluated at 10% of the total value. In addition to the above, two items on the 'fill-in-blanks' were asked for. The maximum value placed on organic chemistry was 12%.

An Analysis of the Chemistry 30 Paper (1960)

1. The time allotted was 3 hours.
2. Optional questions were not used.
3. Fifteen multiple-choice questions were given comprising 10.7% of the paper.
4. 'Completion type' questions made up 10.7% of the paper.
5. Five essay type questions were used. The essay type questions were valued at 17% of the paper.

6. Besides the multiple-choice, completion and essay types of questions, fill-in-blanks, matching and problem-solving questions were used.
7. Questions based on laboratory work accounted for 17% of the paper.
8. The writing of chemical equations made up 5.7% of the paper.
9. 14% of the paper was based on the mathematics of chemistry.
10. 20.4% of the paper was based on organic chemistry.

Comparison of the Chemistry Examination Papers

From the study of the above mentioned chemistry papers (Appendix D) it appears that:

1. The 1936 paper was based entirely upon direct text-book reproductions. More thought-provoking questions appear to have been used in 1960, (e.g. Question 10, Appendix D).
2. A better sampling of types of questions and materials is evident in the 1960 paper.
3. More emphasis was placed on the mathematics of chemistry in 1960.
4. The same emphasis was placed on the completion type of question.
5. More emphasis was placed on the essay type of question in 1960.
6. More emphasis was placed on the laboratory work in 1960.
7. The same emphasis was placed on the writing of equations.
8. In 1960 the section on organic chemistry was valued more than twice that of 1936.

9. More emphasis was placed on the atomic structure, the theory of ionization and hydrolysis in 1960.

An Analysis of the Physics 2 Paper (1936)

1. The time allotted was 2½ hours.
2. The paper consisted of 10 questions. Students were asked to answer seven of which only one was obligatory.
3. The obligatory question was made up of 16 multiple-choice items carrying a value of 16% of the paper.
4. Approximately 40% of the paper was made up of the 'discuss' or 'describe' type of question.
5. Approximately 40% of the paper was based on mathematics.

An Analysis of the Physics 30 Paper (1960)

1. The time allotted was 3 hours.
2. No optional questions were given.
3. No multiple-choice questions were given.
4. 45% of the paper was made up of the short answer type of question. 80.5% of these were problems based on single concepts or principles. Practically all the prescribed concepts and principles were represented.
5. 88.7% of the total paper was made up of mathematical problems.
6. 11.3% of the paper was based on a descriptive material.

Comparison of the Physics Examination Papers

From the study of the above mentioned physics papers it appears that:

1. The 1936 paper called for more descriptive information involving direct text-book reproductions.
2. The 1960 paper was of a highly mathematical nature with a major emphasis upon problem-solving.
3. The problems used in 1936 appear to be of about the same degree of difficulty as the problems used in 1960.

Distribution of the Results on the Final Examinations

1. In 1936, 1199 students wrote the Physics 2 paper. 30% of the students who wrote the physics paper in 1936 were failed.
2. In 1936, 1548 students wrote the Chemistry 2 paper. 30% of the students who wrote the chemistry paper in 1936 were failed.
3. In 1960, 2943 students wrote the Physics 30 paper. The distribution in 1960 was as follows:

   H = 166; A = 617; B = 1023; C = 690; D = 447.

   Approximately 35% of the students who wrote were failed.
4. In 1960, 6496 students wrote the Chemistry 30 paper. The distribution in 1960 was as follows:

   H = 329; A = 1266; B = 2283; C = 1658; D = 960.

   Approximately 35% of the students were failed. Distribution of the pass marks in 1936 could not be obtained from the Department of Education.

A Critical Discussion of the Final Examinations

1. Thought-provoking questions appear to be inadequate on both the 1936 and 1960 chemistry papers.
2. The 1960 papers in chemistry and physics represent a much better sampling of the material covered than do the 1936 papers.
3. The degree of difficulty of the 1936 and 1960 physics papers appears to be the same.
4. A good sampling of problems was used on the 1960 physics paper. These problems appear to be graded in difficulty, and involve single concepts which test the student's understanding of principles. A number of problems involve two or more concepts to test the student's ability to think.
5. The definitions asked for could be answered from memory and did not encourage critical thinking. More emphasis should be given to the use of definitions in problem-solving.

CHAPTER VI

DISCUSSION OF OBJECTIVES AND REGULATIONS

In a study of this nature it would be worth while to compare the stated objectives underlying science teaching in 1935-36 with those accepted in 1959-60.

Some of the aims and objectives underlying the 1935-36 high school physical science programs are indicated below.

1. General

   The correct spelling of all words peculiar to the subject-matter of the various courses should be mastered by students (Appendix A).

2. Chemistry 1.

   Cornish, author of the Chemistry 1 text-book, lists the following objectives:

   (a) training in scientific method

   (b) generalizations

   (c) an appreciation of facts, theories and advancement of science

   (d) an understanding of chemical facts as related to daily life and industry.

3. Chemistry 2, as is indicated in Appendix B, should

   (a) give a general knowledge of inorganic chemistry and the more important laws and theories

   (b) serve as an introduction to organic chemistry

(c) familiarize the student with the methods of qualitative analysis.

(d) bring out more fully the economic and industrial aspects of the subject.

4. Physics 1, as outlined in Appendix B, aims to

(a) ascertain that the student shall obtain a knowledge of the most important principles of the science, and shall be led to realize that these laws are operative in the most familiar phenomena of his own environment

(b) develop a rapid expansion of vocabulary, and eliminate faulty or inadequate concepts and incorrect or careless thinking

(c) correlate physics and mathematics

(d) develop accurate training in the method of scientific thinking.

5. Physics 2 stresses the valuable contribution of applied mathematics to the development of physical science and enables the student to grasp new possibilities in each through their intimate correlation (Appendix B).

No formal statement of specific objectives for the teaching of high school science could be found in either the course outlines issued in 1959-60 or in the text-books used. However, the following aims and objectives were gleaned from these outlines and prescribed text-books:

1. Development of the students' ability to think critically.
2. Acquisition of principles, concepts and facts for the understanding and appreciation of the earth and the universe.
3. Appreciation of the need for conservation.
4. Development of skill in the use of scientific tools with care and precision.
5. Development of competency in problem-solving and precise mode of expression.

It appears that in 1935-36 the major emphasis was placed on the training in scientific method and an understanding of the economic and industrial aspects of science. In 1959-60 emphasis was placed on the development of the ability to think critically and on accuracy in expression and calculation.

This comparison may not be entirely valid because of the incomplete nature of the 1959-60 statement of objectives. However, this inadequacy may be partly overcome by examining one of many current statements of objectives. Perhaps the most comprehensive and representative one is that published in the December 1960 issue of The Bulletin of the National Association of Secondary-School Principals:

1. To acquire those scientific facts, concepts, and generalizations which lead to a better understanding and appreciation of the universe.
2. To develop skill in using many resources for solving problems.

3. To understand the variety of methods employed by the scientists.
4. To appreciate the tentative nature of scientific data and conclusions.
5. To facilitate effective communication of scientific ideas.
6. To nurture the natural scientific interests of each individual.
7. To develop an awareness that man's ability to modify his environment is limited by his understanding of its nature.
8. To appreciate the contributions of scientists.
9. To develop an understanding of the interrelatedness of the various sciences.
10. To develop an awareness that science is but one factor which contributes to man's well-being.
11. To make the pupil aware of his social and moral responsibility to mankind.
12. To practice critical thinking through problem-solving activities and to recognize the applications and limitations of such procedures in nonscience problems.
13. To explore science for new interests, continually evaluating science experiences for career and recreational opportunities.

From the study of the objectives and the structure of the curricula (1959-60) it appears that Alberta schools are designed to meet the needs of a broader section of students of varying ability. This tends to hold students in schools for a longer period of time. The idea is reiterated in the December (1960) issue of The Bulletin

of the National Association of Secondary-School Principals.

> During the past thirty years, the curricula of public high schools have undergone considerable change. Prior to this period, major emphasis was upon college preparatory courses. In many instances, the material presented correlated closely with that found in freshman college courses but was on a more elementary level. Only a small percentage of high-school-age youth was enrolled in these schools. Since then, high schools have become all-inclusive, enrolling practically all youth between the ages of 14 to 17 and preparing them for various avenues of life. These high schools are now providing college entrance, general, and vocational education curricula.[9]

Not only is the science curriculum adapted to promote the aims and objectives of science teaching, but the science teachers are expected to create an atmosphere conducive to the inculcation and appreciation of these aims and objectives.

> The "quality" of our science teachers is crucial, for these teachers create the atmosphere and viewpoint within which the teaching influences the development of children. Books, equipment, building, curricula, and administration are only aids to better instruction. Unless the teacher has the intellectual and emotional maturity, the vision and ability to utilize these aids effectively, he cannot arouse desired ideas and attitudes in the pupils.[10]

Regulations Governing Instruction Time.

In 1935-36 Physics 1 was offered at the grade X level, Chemistry 1 at the grade XI level and Physics 2 and Chemistry 2

---

[9] The Bulletin of the National Association of Secondary-School Principals. Volume 44. Number 260. December 1960, p. 111.

[10] Ibid. p. 137.

were offered at the grade XII level. The average school day was divided into 8 periods and each unit was offered once a day. The duration of each period was 35 to 40 minutes.

In 1959-60 Science 10 was offered at the grade X level, Science 20 at the grade XI level and Physics 30 and Chemistry 30 at the grade XII level. Science 10 and Science 20 were each made up of a half year course in physics and a half year course in chemistry.

Thus, we see that twenty-four years ago, a senior matriculation student took two years of physics and two years of chemistry during his high school career. At present, a senior matriculation student also takes two years of physics and two years of chemistry in high school. In minutes, the time allotted for the instruction of chemistry and physics in 1959-60 was the same as in 1935-36.

The only obvious difference is that now students take physics and chemistry each year. Although this cannot be considered as a strong feature, it appears to have some merit. There is no longer the one year lapse between consecutive physics and chemistry courses.

Regulations Governing Requirement for Senior Matriculation

In 1935-36, all students qualifying for Senior Matriculation Entrance Normal School, First Class, had to meet the following requirements (Appendix A):

(a) Junior Matriculation which included Physics 1 and Chemistry 1.

(b) English Composition 4, English Literature 4.

(c) Six units from

History 4, History of English Literature 1,
Algebra 3, Geometry 3, Trigonometry 1, Physics 2,
Biology 1, Chemistry 2, Latin 3, French 3, German 3,
Greek 3, Music 3.

From the above, it is obvious that a student could enter Normal School and obtain a First Class teaching certificate (license to teach grades one to twelve inclusive) with credit in Physics 1 and Chemistry 1 only.

In 1959-60, matriculants from the high schools of Alberta seeking admission to the Faculty of Education had to meet the following requirements:

(a) a High School Graduation Diploma with "B" or higher standing in English 30, Social Studies 30 and four of: French 30, German 30, Latin 30, Physics 30, Chemistry 30, Biology 32, Mathematics 30, Music 30.

As in 1935-36, so in 1960 it was possible for a student to enter the Faculty of Education with credit in Science 10 and Science 20 equivalent to Physics 1 and Chemistry 1 of 1935-36.

It appears possible for a student to graduate from the Faculty of Education in 1960 with a license to teach Physics 30 and Chemistry 30 without having taken any sciences at the grade XII level. This situation was also possible in 1936. However, in order to obtain a Standard S or a Professional Certificate, a student in 1960 was obliged to take Education 280S. which carried prerequisites or

co-requisites of two full courses in each of the major and minor studies. Although this tends to insure that science teachers will have a stronger science background, there was no apparent regulation which would prevent a student majoring in, say English and minoring in Social Studies from teaching Physics 30 or Chemistry 30. This seems an undesirable situation requiring careful study and assessment.

Admission to the Faculty of Arts and Science in 1936 was the same as in 1960. The science requirements were two of Physics 2, Chemistry 2, and Biology 1 in 1936 and two of Physics 30, Chemistry 30, and Biology 32 in 1960.

CHAPTER VII

DISCUSSION OF RECOMMENDATIONS FOR REVISING THE HIGH SCHOOL CHEMISTRY CURRICULUM

This comparative study of the high school physical science programs for the years 1935-36 and 1959-60 fails to reveal any fundamental difference in "philosophy" of curriculum planning.

It appears that revisions have been made in the past on the basis of the background requirements for first-year university chemistry, and on the inescapable need to incorporate new scientific information periodically into the science courses. The latter objective was generally achieved by either enlarging the content of the courses, or by accommodating the new knowledge by discarding some of the older science concepts.

If this approach to curriculum revision were to continue, then proposed revisions for the high school chemistry program could result from a comparison of the present content of this program with that of the freshman General Inorganic Chemistry.

The inadequacy of this method of revising science curricula has been pointed out by many educators and scientists, some of whom have offered proposals for revision along with their criticisms. What Donald B. Summers of Glassboro State College has to say about the high school chemistry text-books currently used throughout the United States can also be appropriately directed at the chemistry taught in the high schools in Alberta. He states:

> Seemingly, most high school texts, with a few exceptions, present chemistry as it was taught in the first two or three decades of the twentieth century. In the majority of these texts the approach can be termed classical in nature with the emphasis placed on descriptive material.
>
> In the modern approach to the study of high school chemistry, descriptive material is utilized whenever it may be used to illustrate a law, theory, or concept. The emphasis is definitely upon broad generalizations which enable the student to understand and predict specific properties of a species rather than learning a lot of facts pertaining to an element or group of elements.[11]

Furthermore, Summers' recommendations of the concepts to be included in the modern high school chemistry course would more than bridge the gap between the chemistry currently taught in grade XII and the freshman chemistry course offered at the University of Alberta. These recommendations are:

1. The Hildebrand and Powell method of classifying matter.
2. The development of the mole concept using Avogadro's number.
3. The use of atomic and ionic radii in bonding.
4. The recognition of water as a "bent" molecule and a dipole in explaining its peculiar properties and its ability to dissolve some ionic compounds.

---

[11] Journal of Chemical Education. Volume 37, Number 5, May 1960, pp. 263-4.

5. The use of the Bronsted-Lowry acid-base theory.
6. The teaching of equilibrium on a "quantitative" rather than a "qualitative" basis.
7. The teaching of atomic structure with emphasis given to the unpredictable path of the electron and its energy levels.
8. The use of recent decisions of the I.U.P.A.C. (1957) in nomenclature.
9. The use of atomic molecular and ionic geometry to portray the spatial arrangements of ions in ionic compounds.
10. The use of the "common-sense" approach in chemical reasoning commonly called the "factor-label" method instead of the formula method in solving problems.
11. The use of complex-ions in explaining certain types of chemical reactions.
12. The use of coordination number and oxidation-numbers in the development of valence concepts.
13. The use of electrochemistry (Faraday's Laws), with the mole concept as a background for the prediction of oxidation-reduction reactions and the explanation of electrolytic reactions.

Proposals for revision such as those made by Summers have been useful in providing some direction for the gradual changes that have been made in the science programs in the past. However, it is only recently that a concerted, all-out effort has been initiated in the

United States on the problem of developing modern high school chemistry programs. Two committees under the National Science Foundation, are studying the problem. These are called the Chemical Bond Approach (CBA) Project and the Chemical Education Material (CHEM) Study.

The Chemical Bond Approach, at Earlham College is directed by Laurence E. Strong of Earlham College and M. Kent Wilson of Tufts University, Medford, Massachusetts. The Chemical Bond Approach is based on the organization of chemistry instruction around a central theme, this theme being the centrality of the chemical bond. To this end, a good deal of attention has been given in the course to the use of geometry in chemical reasoning. The syllabus is built around atomic structure, chemical bond properties, and types of reactions. An interesting characteristic of the C B A Chemistry is the belief that chemistry can be made fascinating to students and, at the same time, much memorization of chemistry data might be deleted.

The CHEM Study is being prepared at Harvey Mudd College, Claremont, California, under the chairmanship of Glenn T. Seaborg, of the University of California, and directed by Arthur Campbell of Harvey Mudd College. In order to avoid needless duplication of the content items in the high school and college courses, the committee worked on a project of 'identifying the irreducible minimum of basic fundamentals that could and should be taught in the high school

course and on which the college course would be built'.[12]

The two above mentioned study groups are endeavoring to make a careful and complete re-examination of the chemistry program for the high schools. Initial results on the effectiveness of the textbooks produced by these two groups are very encouraging. Undoubtedly the efforts of these studies will have considerable influence on the future course of the development of the high school chemistry program in Alberta.

---

[12] The Science Teacher, Volume 28, Number 3, April 1961, p. 16.

CHAPTER VIII

DISCUSSION OF RECOMMENDATIONS FOR REVISING THE HIGH SCHOOL PHYSICS CURRICULUM

This comparative study of the high school physics programs for the years 1935-36 and 1959-60 reveals no significant difference in the two curricula. With the exception of moving some concepts to different grade levels, the subject matter content is essentially the same. However, considerably more emphasis was placed on laboratory work and mathematical exercises in 1959-60 than in 1935-36. This is in line with current objectives of science teaching.

A serious weakness in the present high school physics program is the inadequate treatment of modern physics, especially electronics, rocketry and nuclear physics. Students leave high school with very little knowledge of the rate of progress in these fields. The real significance of physics cannot be appreciated if the most modern ideas taught are more than 100 years old. It is difficult to maintain student interest when the physics read about in newspapers and magazines seems to be at such variance with the high school physics course. The impression may be left that all physics is at least 100 years old and that nothing new is being added. Since more physics has been discovered in the past 25 years than in all of the previous history of the subject, some effort should be made to insure that

students will be left with a more adequate perspective in this area.

Many American educators and scientists have been aware of the inadequacies of the high school physics programs and a number of experimental studies have been made. An experiment which is arousing considerable interest today is the one conducted by the Physical Science Study Committee (PSSC). These projects originated at the Massachusetts Institute of Technology. The Physical Science Study Committee is made up of a large group of American scientists and teachers under the chairmanship of Prof. J. Zacharias of M. I. T. and is backed by the National Science Foundation. This committee has recently completed a re-organization of course content and revision of laboratory work.

Dr. J. Zacharias, while speaking on this project to a group of physics teachers, stated:

> Physics education had simply not kept abreast of the advances in scientific discovery and conceptual development. In other cases, the desire to give adequate coverage led to the attempt to add the new without pruning away any of the old. Courses are cluttered with an enormous amount of material. Under such circumstances, secondary school physics was reduced to a course of memorization of what scientists know. Little attention was devoted to the learning how scientists know, or to discovering the excitement of learning by the experimental method.
>
> It was finally decided that gadgets - refrigerators, automobiles, airplanes and radio circuits - had little place in a basic physics course that dealt with concepts.
>
> Emphasis was placed on the basic ideas with which modern physicists explore and describe the universe around us, instead of application. This required a solid description of wave kinematics, Newtonian mechanics (including

> momentum and energy concepts), and the basic concepts of magnetic and electric phenomena.[13]

This course is designed to show the students the structure of physics and how physics was discovered and understood by man. It concentrates on fewer facts. Interrelationships of the branches of physics are stressed and considerable time is spent on developing a continuity in the physics program. This is in contradiction to the traditional approach in which each branch was treated separately as a unique field of study. In this PSSC course, stress is placed on laboratory work in which concepts are developed and not just asserted.

Besides writing a text-book entitled "Physics", this Committee has also produced a laboratory manual, a set of achievement tests, teacher's guides, monographs and films. All of these materials are designed to supplement the text-book material.

The PSSC physics course has gone beyond the experimental stage. It was tested extensively in a large number of high schools in the United States between 1957 and 1960. The results have been gratifying. The Committee claims that the program appeals to a large percentage of secondary school students, including those inclined toward the humanities, and that they do well in it. As a result of this

---

[13] Science Teacher's World. New York. Edition 1, March 15, 1961. p. 1.

evidence the PSSC Physics program has been approved and adopted as the prescribed high school course in many schools of the United States.

The officials of the Department of Education are aware of the inadequacies of the physics program in Alberta high schools. The PSSC project has been under careful scrutiny by some members of the Department since its inception and has been deemed worthy of a trial in selected high schools. The machinery has been already set up to try this new physics course with 20 grade XII classes and 20 grade XI classes during the year 1961-62. Although this experiment is proceeding with evident caution, there is no doubt that the PSSC project will have considerable impact on future revisions of the high school physics curriculum in this province.

CHAPTER IX

DISCUSSION OF THE ROLE OF LABORATORY WORK IN THE SCIENCE

Today, more than at any other time in the past, student activity in the laboratory is considered essential in the teaching of high school science. This objective is not being fully realized in the schools of this province. The situation in this regard was recently brought to light in these words under Inspection and Supervision in the Fifty-fifth Annual Report of the Department of Education:

> The high school inspectors reported that physical facilities for the teaching of science were gradually improving. Some schools were well equipped with rooms, laboratories, materials and science reference books.
>
> With respect to teaching procedures, lectures and demonstrations were widely used, but there was little evidence of much laboratory work by the pupils.
>
> In a number of city schools special science courses have been developed to meet the needs of non-matriculating and diploma students. The content of these courses was of a general nature. There is some question, however, that the lecture or lecture-discussion method which was commonly used is actually well suited to these courses. It would appear that more demonstrations and laboratory exercises would give both more powerful motivation and more effective learning.[14]

---

[14] Province of Alberta. Fifty-fifth Annual Report of the Department of Education, Published by Order of the Legislative Assembly. Queen's Printer, 1961. p. 47.

Although science educators agree on the need for laboratory work in the teaching of science, there is no general agreement on the function and nature of experimentation by students. The criticism of the traditional approach to experimental work in science is expressed by Richardson in these words:

> The "individual laboratory" has often been a slavish following of the printed directions in the laboratory manual; seldom have the students engaged in true experimentation, and rarely has their work been individual.
>
> The laboratory manual can be used effectively by the thoughtful science teacher; instead of serving as a "cook-book" to be followed step by step, the laboratory manual can be a source of many ideas for boys and girls. It can be a source of ideas for procedures to be used in solving their laboratory problems.
>
> But when the laboratory and its emphasis on the investigation or research-type exercises disappear from day-in, day-out science teaching, then the heart and chief inspiration of science as a form of human endeavor has been lost.[15]

Yet many teachers have questioned the research-type laboratory work at the high school level. They claim that the prime purpose of laboratory work at this level should not necessarily be research, but rather to illustrate and verify principles that have been known for years and to develop an appreciation of the works of scientists and research. Furthermore, many feel that it is almost impossible to do

---

[15] J. S. Richardson, Science Teaching in Secondary Schools. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1957, pp. 68, 75, 70.

any 'true' experimental work at the high school level under the present conditions. Until such time as class enrolments and prescribed content are reduced, the 'cook-book' method of teaching laboratory work has its place in the school curriculum.

A further criticism of the investigative laboratory exercise stems from criticisms of the concept of "scientific method".

> High school students of science invariably hear a somewhat indistinct and elusive process called the scientific method. Commonly, this process has been represented as one of intellectual orderliness from which all scientific discoveries arise and students have been asked to accept the universality of this method in the solution of social as well as of scientific problems. However, this popular concept of scientific method has been vigorously challenged, for example Conant and Schwab, and today it is generally agreed that there is no single pattern of thought or behavior which provides a sure guide to scientific discovery. Similarly there is no single curriculum pattern or set of criteria which provides a sure guide to a quality science program in the American high school.[16]

It is significant that the new experimental programs in chemistry and physics mentioned above adhere to the point of view expressed by Richardson. Zacharias expresses the nature of laboratory experimentation in the PSSC physics course as follows:

---

[16] The Bulletin of the National Association of Secondary-School Principals. Quality for Secondary Schools, Service Organ for American Secondary Schools, Volume 44. Number 260. December 1960. p. 77.

> Closely linked to the program is an imaginative series of laboratory experiences using specially devised equipment. This equipment makes use of the simplest components, and the students learn science through experimental situations presented as "open-ended" questions. The basic idea of the experiment is discussed carefully, but few direct instructions are given.
>
> In this way, students are led to do as much as possible on their own. Laboratory becomes an imaginative workshop for the investigation of basic concepts and relationships.[17]

The basic approach to laboratory work in the Chemical Bond Approach is indicated in these words:

> Successful laboratory work in the CBA program means that the student not only collects data in the laboratory, but he also applies ideas to his data. The laboratory experiments are presented as problems to be explored or, if you wish, as puzzles to be solved. In so far as possible, it is left to the student to decide what information he needs to solve the problem. Ideally, some information should come from the laboratory and some from the literature. These are fitted into a logical scheme based on a set of assumptions and often some mental model. Logical reasoning leads to a reasonable solution to the problem.[18]

The last two quotations imply the superiority of the research-type of experimentation in high school science, and intimate that this approach imparts to the student a better understanding of the nature of the research activity of the scientist.

---

[17] Science Teachers' World. Edition 1. New York. March 15, 1961. p. 1.

[18] CBA News Letter. No. 9. February, 1961. Chemical Bond Approach Project. Earlhorn College. Richmond, Ind.

CHAPTER X

RECAPITULATION AND RECOMMENDATIONS

A. Recapitulation

1. There appears to be no significant difference in the quality or quantity of content in physics prescribed in the two years under consideration. In 1935-36 the major portion of the prescribed content was of a descriptive nature. In 1959-60 there was an apparent shift from the descriptive type of science to problem solving and laboratory work.

2. It is evident that more chemistry of a varied nature was prescribed in 1959-60 than in 1935-36. The major portion of the content prescribed in 1935-36 consisted of the study of elements and their compounds. In 1959-60, more emphasis was placed on modern concepts such as the structure of the atom, the theory of ionization, electrovalence and covalence.

3. The stress of laboratory work in chemistry in the two programs is the same, while much more emphasis was placed on experimental work in physics in 1959-60 than in 1935-36.

4. The 1960 departmental examinations were more representative of the course content than those of 1936. A better variety of types of questions is evident on both physics and chemistry papers in 1960.

5. The instruction time allotted to the teaching of physics and chemistry at the high school level was the same in both years.

6. Requirements for matriculation in 1959-60 were equivalent to those in 1935-36.

7. There appears to be no significant difference in the objectives listed between the two years under consideration although the stress seems to shift from emphasis on the understanding of the scientific method (1935-36) to critical thinking through problem solving (1959-60).

B. Recommendations

1. The two programs in physics and chemistry under study were drawn up 25 years apart, in the years 1935-36 and 1959-60 respectively. Since the programs are approximately equal, even though drawn up at the beginning and end of a period during which profound and far-reaching discoveries have been made in the areas, surely a serious need for revision is indicated. A glance at the recent experimental studies points up the importance of incorporating current research knowledge in high school science curricula.

2. The apparent shift from the descriptive type of science (1935-36) to laboratory work and application of mathematics (1959-60) appears to be in concurrence with those objectives of science teaching which emphasize the development of the scientific method, critical thinking and problem solving.

3. The material prescribed in 1959-60 does not appear to meet the demands of the present day social and economic conditions in that the most modern concepts in chemistry and physics are not given

adequate treatment.

4. It appears to be possible to up-grade the high school physical science course by incorporating many of the concepts taught in first-year chemistry at university level.

5. There is an evident need to improve laboratory work at all grade levels in high school science and perhaps some attention should be given to the more recent thinking on the purpose and nature of this laboratory work.

6. The Cameron Commission recommends Departmental examinations at the grade X and grade XI levels. Because of the flexible nature of our curricula and the tendency to emphasize grouping of students according to ability, it is rather difficult to see the purpose of standardized examinations at these levels. Perhaps it would be wiser to hold comprehensive examinations at the grade XII level which would include general principles studied in Science 10 and Science 20. These examinations would be taken by students planning to enter University and would be prepared by a University Matriculation Board. The students working towards a general diploma would not need to write these examinations, and would be recommended by teachers as at present.

7. The Department of Education follows a policy of failing 35% at the grade XII level (15% - D standing and 20% - C standing). This is difficult to justify since most of the weaker students are eliminated before they reach the grade XII level. Perhaps it would be wiser to set certain goals or standards for achievement, especially for University entrance matriculation.

8. The Department of Education uses the same system for transmuting raw scores to percentages in Biology 32 as in Physics 30. Approximately 5% of the students get H's and 15% get D's. Biology 32 has no prerequisite while Science 20 (and possibly Math. 20) are required for Physics 30. Most of the weak students register in Biology 32, while only the top third of the student population takes Physics 30. It would be interesting to determine what would happen if the students who receive C standing in Physics 30 and the students who receive B standing in Biology 32 were to register in another science course, say Chemistry 30, and write the same examination.

9. A periodic review of the science curricula through regularly established procedures is desirable and necessary.

10. Constant scrutiny of new programs could be of considerable value in frequent revisions of science courses.

11. A comprehensive historical study of trends in curriculum changes in high school physical science in Alberta is recommended as a follow-up to this study.

12. A comparison of our science curriculum with those of other countries might be very worthwhile.

BIBLIOGRAPHY

BIBLIOGRAPHY

The Bulletin of National Association of Secondary-School Principals. Quality for Secondary Schools. Service Organ for American Secondary Schools. Volume 44. Number 260. December 1960.

A CBAC Progress Report. Chemistry. A Science Service Publication. Washington 6, D.C. Sept. 1960.

Chemical Bond Approach Project. *CBA Newsletter.* No. 9. Earlham College. Richmond. Feb. 1961.

Conant, James B. *Modern Science and Modern Man.* Doubleday Anchor Books. New York: Doubleday and Company, Inc., 1953.

Conant, James B. *On Understanding Science.* New Haven: Yale University Press, 1947.

Cornish, G. A. and Smith, A. *A Textbook for High Schools.* Toronto: The MacMillan Co. of Canada Ltd., 1932.

Cornish, G. A. and Smith, A. *A Laboratory Manual to Accompany Chemistry.* Toronto: The MacMillan Co. of Canada Ltd., 1930.

Croal et al. *Chemistry for Secondary Schools (Advanced edition).* Toronto: The Copp Clark Publishing Co. Ltd., 1955.

Department of Education. *A Handbook for Secondary Schools.* Edmonton: King's Printer, 1930.

Department of Education. *Course Outlines for Science 10 and Science 20 1959-60.* Edmonton: Queen's Printer, 1959.

Department of Education. *Curriculum Guide for Alberta Secondary Schools.* Edmonton: Queen's Printer, 1950.

Department of Education. *Examination Papers in Physics and Chemistry for the year 1960.* Edmonton: Queen's Printer, 1960.

Department of Education. *Examination Papers in Physics and Chemistry for the year 1936.* Edmonton: King's Printer, 1936.

Department of Education. *Fifty-fifth Annual Report.* Edmonton: Queen's Printer, 1961.

Department of Education. *Grade IX Curriculum Guide for Science.* Edmonton: Queen's Printer, 1959.

Department of Education. *Laboratory Exercises in Chemistry 30*. Edmonton: Queen's Printer, 1957.

Department of Education. *Laboratory Exercises in Physics 30*. Edmonton: Queen's Printer, 1957.

Department of Education. *Regulations of the Department of Education relating to Programme of Studies and annual examinations for Secondary Schools for the year ending June 30, 1936.* Edmonton: King's Printer, 1935.

Department of Education. *Revised Outlines for Chemistry 30 and Physics 30, 1959-60.* Edmonton: Queen's Printer, 1959.

Department of Education. *Senior High School Handbook 1958-59*. Edmonton: Queen's Printer, 1958.

Department of Education. *Thirty-first Annual Report*. Edmonton: King's Printer, 1936.

Department of Education. *What is and What might be in Rural Education in Alberta*. Edmonton: King's Printer, 1935.

Edmonton Journal Editorial, March 9, 1960.

Eubank, H. L., Ramsay, J. M. and Rickard, L. A. *Basic Physics for Secondary Schools (Alberta Edition)*. Toronto: The MacMillan Co. of Canada Ltd., 1959.

Faculty of Education, University of Alberta. *Brief to the Royal Commission on Education (Part two)*. Edmonton: Queen's Printer, 1958.

Hogg, J. C., Cross, J. B. and Little, E. P. *Physical Sciences for Canadian High Schools*. Toronto: D. Van Nostrand Company (Canada), Ltd., 1957.

Journal of the National Science Teachers Association. *The Science Teacher*. Volume 28, Number 3. Washington 6, D. C. April 1961.

Littler, W. *Elementary Chemistry Book 11*. Toronto: Clarke, Irwin and Co. Ltd., 1934.

Littler, W. *Elementary Physics*. Toronto: Clarke, Irwin and Company Limited, 1955.

Littler, W. *Laboratory Manual to Accompany Book 11*. Toronto: Clarke, Irwin and Co. Ltd., 1934.

Merchant, F. W. and Chant, C. A. *The Ontario High School Physics. Revised Edition.* Toronto: The Copp Clark Company, Ltd., 1927.

Merchant, F. W., Chant, C. A. and Cline, G. A. *Mechanics, An Elementary Text-Book.* Toronto: The Copp Clark Company, Ltd., 1931.

National Science Teachers Association. *New Developments in High School Science Teaching.* Washington: Department of the National Education Association, 1960.

Pickard, N. J. and Radomsky, S. W. *Introductory Chemistry and Physics.* Toronto: D. Van Nostrand Co. (Canada), Ltd., 1960.

Province of Alberta. *Report of the Royal Commission on Education.* Edmonton: Queen's Printer, 1959.

Report of Conference on Nation-wide Problems in Science Teaching in the Secondary Schools, "Critical Years Ahead in Science Teaching". Cambridge: Harvard University Press, 1953.

Richardson, J. S. *Science Teaching in Secondary Schools.* Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1957.

Schwab, J. T. "The Nature of Science Knowledge as Related to Liberal Education", *The Journal of General Education, III*, 1949.

Scott, D. B. "Modern Physics in High Schools". *Private Communication*, December 28, 1960.

Summers, D. B. Are High School Chemistry Texts Up-to-date? *Journal of Chemical Education.* Volume 37, Number 5, May 1960.

The Science Teacher's World. Edition 1. New York: March 15, 1961.

U. S. Department of Health, Education, and Welfare. *Analysis of Research in the Teaching of Science.* Washington: United States Government Printing Office, 1958.

Whitehead, A. N. *The Aims of Education and Other Essays.* New York: New American Library, 1949.

APPENDICES

APPENDIX A

REGULATIONS OF THE DEPARTMENT OF EDUCATION 1935-36

Regulations of the Department of Education relating to Programme of Studies and annual examinations for Secondary Schools for the year ending June 30, 1936.

Edmonton: Printed by W. D. McLean,
King's Printer 1935

1. There has been prepared (1930) to accompany these Regulations A Handbook for Secondary Schools, Alberta, containing details of the requirements of each unit of the Programme of Studies. If any differences are found in the outline of courses in the Handbook and the Regulations, the statement contained in the Regulations is to be taken as final.
2. The minimum requirement for Normal Entrance of Junior Matriculation is credit in twenty-one units of work as outlined in the Programme of Studies for Secondary Schools. Candidates will be required to possess standing in each of twenty-one prescribed units before securing diplomas. That is, credit in Algebra 2 will not give credit in Algebra 1.
3. Students in all schools may be recommended for credit by the teacher or principal in the following High School subjects: General Science 1.
4. The correct spelling of all words peculiar to the subject-matter of the various courses should be mastered by students.

5. In order to obtain credit, candidates will be required to secure 50 per cent in each unit. N.B. All students qualifying for Entrance to Normal School, Second Class (Grade XI) in 1936 must hold credit in the following subjects of the Alberta High School Courses:

    1. English Literature 1, 2 and 3.
    2. English Composition 1, 2 and 3.
    3. History 1, 2 and 3.
    4. Algebra 1 and 2.
    5. Geometry 1 and 2.
    6. Arithmetic 1.
    7. Art 1.
    8. Geography 1.
    9. General Science 1.
    10. Physics 1 or Agriculture 1.
    11. Chemistry 1 or Agriculture 2.
    12. Two units to be selected from either (a) or (b) below:
        - (a) Either Latin 1 and 2 or French 1 and 2 or German 1 and 2 or Greek 1 and 2.
        - (b) Art 2, Music 1, Music 2, Manual Training 1, Manual Training 2, Household Economics 1, Household Economics 2, the Science subjects not already mentioned.

The subjects required for Entrance to Normal School, First Class (Grade XII), are as follows:

(a) Credits outlined above for Second Class

(b) English Composition 4, English Literature 4

(c) Six units to be selected from History 4, History of English Literature 1, Algebra 3, Geometry 3, Trigonometry 1, Physics 2, Biology 1, Chemistry 2, Latin 3, French 3, German 3, Greek 3, Music 3.

For information concerning Matriculation to the University of Alberta, students should consult the Matriculation Bulletin of the University. By proper selection of the twenty-one units students may obtain both Normal School Entrance (Second Class) and Matriculation to the Faculty of Arts and Sciences.

Regulations Pertaining to the Operation of Alberta Senior High Schools 1959-60

A Senior High School Handbook

Province of Alberta, Department of Education 1959.

1. Classification of High School Courses

The Senior High School courses are classified as Constants and Electives.

(a) CONSTANTS

These are compulsory courses which are required of all high school students.

(b) ELECTIVES

All courses other than Constants are classified as Electives.

2. Attendance Requirements

(a) All students, in order to qualify for credits in senior high school courses, must take their classroom instruction during school hours as part of a regular school program based on a specific time schedule, or correspondence instruction under the direction of the Department of Education. (The only exception is credits in Music obtained through private study.) To be eligible to receive credits for a full year's program a student must be in regular attendance throughout the school year. For the past several years it has been the practice to make

certain disallowances for students whose attendance fell below a reasonable number of days. Decisions for such disallowances are the responsibility of the principal.

(b) A student who "repeats" a course, either because of previous failure in that course, or for the purpose of securing a higher standing, must attend classes regularly.

3. Letter Gradings

Standings in non-examination courses of the high school program is indicated by means of letter gradings. The following schedule gives the range of scores on a scale of 0 to 100 corresponding to each of these gradings:

Letter Gradings	Range on Scale
H	80-100
A	65- 79
B	50- 64
C	40- 49
D	0- 39

4. Standing Required for Credit

To earn the credits attached to any course on the high school program, a student must achieve at least a "C" standing in that course.

(a) Instruction in the second or third courses of any CONSTANT may be taken only by students who have achieved at least a "C" standing in the first or second course, respectively.

(b) Instruction in the second-year course of an ELECTIVE in any sequence may be taken by students who have at least a "b" standing in the first-year course of that elective.

(c) Instruction in the third-year course of any elective in sequence may be taken only by students who have at least a "B" standing in the preceding second-year elective.

5. The High School Diploma

The High School Diploma is an official document issued by the Department of Education, certifying that the holder has completed the required program of instruction through attendance at a high school, or through correspondence instruction under the direction and supervision of the Department.

This diploma does not itself grant matriculation. The student is expected to have so arranged his program that it includes the subjects especially required by the university and that he has secured the necessary standing in these subjects.

6. Minimum Requirements

Subject to regulations governing the choice of subjects and the standing required for obtaining credits in each subject, the following are the minimum requirements for the High School Diploma:

(a) Forty to forty-six credits in prescribed constants as follows:

Language 10, 20	10 credits

Literature 10, 20	6 credits
English 30	5 credits
Social Studies 10, 20, 30	15 credits
Health and Personal development 10	2-5 credits
Physical Education 10	2-5 credits

(b) Fifty-four to sixty credits in electives.

(In other words, a sufficient number of credits in electives to make a grand total of at least 100 credits) including:

i. Credit in at least one mathematics course.

ii. Credit in at least one science course.

iii. Credit in one Grade XII subject in addition to English 30 and Social Studies 30.

7. Requirements for Matriculation Into the University of Alberta

GENERAL REQUIREMENTS

Matriculants from the high schools of Alberta seeking admission to the University will have to possess:

1. A High School Graduation Diploma with
2. "B" or higher standing in the required courses of Grade XII as set forth in the prescriptions of the various schools and faculties, and
3. An average in these courses of at least 60 per cent.

FACULTY OF ARTS AND SCIENCE

For the degree of B.A.: the general requirements with credit in:

1. English 30
2. Social Studies 30
3. Mathematics 30
4. French 30 or German 30 or Latin 30

5 and 6. Two of: Chemistry 30
Physics 30
Biology 32
A second Grade XII language.

For the degree of B.Sc.: the general requirements with credit in:

1. English 30
2. Social Studies 30
3. Mathematics 30
4. Chemistry 30
5. French 30 or German 30 or Latin 30.
6. Physics 30 or Biology 32 (Physics 30 is recommended)

(Note: Students planning to enter patterns in Chemistry, Geology, Mathematics or Physics should take Chemistry 30 and Physics 30 and will be expected to present credit in Mathematics 31.)

FACULTY OF EDUCATION

For the degree of B.Ed.: the general requirements with credit in:

1. English 30

Social Studies 30

3, 4, 5 and 6. Four of Mathematics 30
Chemistry 30
Physics 30
Biology 32
French 30
Latin 30
German 30
Music 30

(Note: Candidates intending to specialize in Household Economics

or in Physical Education should offer Chemistry 30).

For admission to the Junior E program (one year): a High School Diploma and standing (B or higher) in English 30, Social Studies 30 and two other Grade XII examination subjects, with an average of 60% in the four subjects.

(Note: 1. Students completing the Junior E program successfully receive the interim Junior E Certificate issued by the Alberta Department of Education. Before this certificate may be made permanent, the holder must provide evidence to the Department of Education through the Faculty of Education that he possesses matriculation standing that will admit him to a Bachelor of Education program, must teach successfully in Alberta schools for two years, and must be recommended by a Superintendent or Inspector of Schools.

2. A student who holds the Interim Junior E Certificate may not proceed on a Bachelor of Education program until he has provided evidence that he possesses matriculation standing that will admit him to a Bachelor of Education program.)

APPENDIX B

OUTLINES OF REQUIREMENTS 1935-36

N.B. Details of all courses except those included in these pages are obtainable in the Hand-book for Secondary Schools, Alberta.

Physics 1.

Text-book - Merchant and Chant: Ontario High School Physics (Revised Edition) (Copp Clark Co.)

N.B. - The following paragraphs give the number of the chapters in the Revised Edition of the text-book which should be covered, also paragraphs which may be omitted.

(a) Molecular Theory

Chapters XV and XVI (omitting Par. 149, 150, 153 and 155).

(b) Heat

Chapters XXII, XXIII and XXIV.

Chapter XXV (omitting par. 243, 244, and 245).

Chapter XXVI.

Chapter XXVII (omitting par. 273-275).

Chapter XXVIII and XXX.

(c) and (d) Wave Motion and Sound

Chapter XVII (omitting par. 159-161 and 175-177).

Chapter XVIII (omitting par. 186-191).

Chapter XIX (omitting par. 196-198, 204-206, and omitting mathematical calculations on vibrations of strings. Give only factors upon which frequency of an air column depends, and relation of wave-lengths to lengths of open and closed

air-columns).

Chapter XXI.

(e) Light

Chapter XXXI (omitting par. 320).

Chapters XXXII and XXXIII.

Chapter XXXIV (omitting par. 341).

Chapter XXXV (omitting par. 351 and 353).

Teach index of refraction and experimental determination.

Leave out geometric proof.

Chapter XXXVI (omitting par. 364 and 367).

Chapter XXXVII (omitting par. 377, 379-383).

Chapter XXXVIII (omitting par. 385, 389-392).

N.B. - The course in light should be made as experimental as possible, but the use of drawings representing images with plane and curved mirrors and lenses will be found necessary for purposes of illustration.

(f) Electricity and Magnetism

Chapter XXXIX.

Chapter XLI (omitting par. 441, 443).

Teach Ohm's Law. Par. 525, 526, 527 along with 448.

Chapter XLII (omitting par. 450-452, 454-456, 458-460).

Chapter XLIII (omitting par. 461-462, 464, 468-473).

Chapter XLIV (omitting par. 476).

Chapter XLV (omitting par. 499, 500, 502).

Teach induction coil, but omit self-induction and condenser.

Chemistry 1.

For details of course, see Hand-book (1930 edition).

Text-book - Cornish: Chemistry, A Text-book for High Schools (MacMillan Co.), omitting Chapters XIV, XVIII, XIX and XX.

In the list of experiments given in the hand-book to be performed by the student or demonstrated by the teacher, Nos. 38, 39, 40 and 41 should be omitted as they are not contained in the chapters required for study.

Instructions for the required experiments will be found in A Laboratory Manual in Chemistry (Cornish and Smith).

Physics 2.

Text-book - Merchant, Chant and Clive: Mechanics, an Elementary Text=book (Copp Clark Co.), omitting paragraphs 104, 113, 169, 170 and 218, and chapters XXIV, XXV, XXVI, and XXVIII.

Chemistry 2.

Text-books - Littler: Elementary Chemistry Book II.
Littler: Laboratory Manual to accompany Book II.

This unit should be offered only in those schools where the instructor in Chemistry holds at least, standing in Chemistry 2 or its equivalent, and where the laboratory equipment is adequate for performing all the prescribed experiments.

The Introduction, Complex Silicates, pp. 97-101, Chapter XII, Chromium, pp. 234-236, Chapters XXII, XXIV, XXVI, and the

Conclusion of the authorised text may be treated as required reading; and need not necessarily be taken up in class.

Details of Courses from Hand-book (1930 edition).

Chemistry 1.

I. Introductory

(a) The field of chemistry and the importance of science.

(b) Physical and chemical change - kinds of chemical change - union and decomposition.

(c) (1) Kinds of substances - elements and compounds - distinction between mixtures and compounds.

(2) Elements - occurrences - free and combined - number, distribution and relative importance - classification - metals and non-metals.

II. An experimental course defined as follows:

(a) A study of the following elements and their most important compounds - hydrogen; oxygen; nitrogen; carbon; sulphur; chlorine; potassium; sodium; calcium.

(1) Preparation; physical and chemical properties.

(2) Occurrence; natural and economic importance.

(b) Air - composition - importance of each constituent.

(c) Water:

(1) Analysis and synthesis.

(2) Inorganic and organic impurities, sources, purification.

(3) Water of crystallization - efflorescence, deliquescence, dehydration.

(d) Solutions - liquid and gaseous - properties - unsaturated -

solubility curve - effect of change in temperature - precipitation, crystallization, filtration.

(e) Combustion - ordinary, slow, spontaneous, ignition, temperature, flames of candle and Bunsen burners, oxidation and reduction.

(f) Oxides, acids, bases, salts - properties - neutralization.

III. General Chemistry.

(a) Laws - law of conservation of mass - laws of definite and multiple proportions; Boyle's and Charles' Law: law of combining weights; Gay Lussac's Law of volumes.

(b) Theories - Atomic and molecular theories, Avogadro's hypothesis; ionization; value of theories in explaining facts and laws and in discovering new truths.

(c) Valency - formulae, chemical nomenclature, easy calculations.

Chemistry 2.

Introduction

The second course in chemistry, outlined below, is intended to give a general knowledge of inorganic chemistry, and of the more important laws and theories relating thereto; to serve as an introduction to organic chemistry; and to familiarize the student with the methods of qualitative analysis. The major portion of the time will be devoted to the first section of the course. The organic compounds studied are those which are of the most direct significance in daily life. It is expected that the method of treatment will be predominately

experimental, but laboratory work should be supplemented by discussions, some of which should be designed to bring out more fully the economic and industrial aspects of the subject.

Outline of Course

A. Inorganic Chemistry

1. (a) A study of the following elements and of their most important compounds:
   Hydrogen; helium, lithium; sodium; potassium; copper; silver; gold; calcium; strontium; barium; radium; magnesium; zinc; mercury; boron; aluminium; carbon; silicon; tin; lead; nitrogen; phosphorus; arsenic; antimony; bismuth; chromium; tungsten; oxygen; sulphur; manganese; fluorine; chlorine; bromine; iodine; iron; cobalt; nickel; platinum.

   (b) Their occurrence, mineralogy, and metallurgy.

   (c) Group characteristics - Periodic Law.

   (d) Economic uses of the elements and their compounds and common processes of manufacture.

2. (a) Laws of Chemistry - Law of Definite and Multiple Proportions; Boyle's Law; Charles' Law; Gay Lussac's Law of Volumes; Dulong and Petit's Law; Raoult's Law; Periodic Law.

   (b) Theories - Avogadro's Hypothesis; Molecular Theory; Atomic Theory; Ionization; Electrons.

(c) Acids, Bases, Salts, Neutralization - Normal Solutions.

(d) Valence; Chemical Formulae; Chemical Equations; Calculations.

B. Organic Chemistry

Carbohydrides; Carbohydrates; Alcohols; Acids; Esters; Fats; Soaps; Explosives; Poisonous Gases.

Physics 1.

Introduction

The first course in physics aims to secure that the student shall obtain a knowledge of the most important principles of the science, and shall be led to realize that these laws are operative in the most familiar facts of his own environment. The rapid expansion of vocabulary, incident to progress in the science, is attended with some dangers, and is equally important that the student shall understand clearly the meanings of all the terms that he is called upon to use. Faulty or inadequate concepts, and consequently incorrect or careless thinking, must be prevented at all costs, even at the reduction of the body of material here indicated.

At no point in the school course is it more necessary to correlate the work of the various subjects than in the teaching of physics. Pupils who are passably good in arithmetic, algebra and geometry and theoretical physics fail utterly when they are required to use mathematics in the solution of physical problems.

Accurate training in the method of scientific thinking, i.e., in isolation of the known facts, in determination of the end to be

achieved, in a decision as to the method to be employed, and in checking the results obtained is secured only by frequent and accurate repetition.

Outline of the Course

A. Molecular theory of the composition of matter.

- (1) Molecular forces; cohesion, adhesion, surface tension, capillarity.
- (2) Molecular motions explaining phenomena of heat expansion, gas pressure, diffusion, osmosis.

B. Heat.

- (1)
    - (a) Nature and sources of heat.
    - (b) Expansion of solids, liquids and gases when heated.
        - (i) Solids - increased in length and diameter, coefficient of expansion, unequal expansion, practical applications.
        - (ii) Liquids - coefficient of expansion, practical applications - thermometer, its construction, graduation, Fahrenheit and Centigrade scales. Maximum density of water, natural importance.
        - (iii) Gases - Equal expansion of all gases, Charles' Law.
- (2) Heat transmission
    - (a) Methods - conduction, convection, radiation.
    - (b) Practical applications - heating and ventilating systems in houses, large buildings, mines - hot air, hot water and steam systems.

(3) Heat measurements: Calorie, B.T.U., Thermal capacity, specific heat, practical applications.

(4) Change of State.

(a) Solids to liquids, liquids to solids.

(i) Freezing and melting points - effect of pressure and of substances in solution - change of volume.

(ii) Heat of fusion - heat required for solution, freezing mixtures, practical applications.

(b) Liquids to gases, gases to liquids.

Evaporation - conditions affecting rate of evaporation.

Heat absorbed, dew point, humidity and vapor pressure.

(c) Boiling point - effect of pressure, altitude and substances in solution in boiling point - distillation.

(d) Practical applications - cooling by evaporation, artificial cooling, hydrometer.

C. Wave Motion

(1) Energy Transmission - direct contact, conduction, convection, currents, wave motion.

(2) Wave Motion - characteristics, modes of production of waves, transverse and longitudinal waves, wave length, amplitude, frequency, relation between velocity, wave length and frequency, reflection of waves, standing waves, nodes and loops.

(3) Energy transmitted by wave motion - sound, light, electricity, e.g., wireless telegraphy and radio-phone - media of transmission.

D. Sound

(1) Production, transmission, velocity, reflection, echo, relation of velocity to medium of transmission.

(2) Intensity of sound, relation of density of medium, amplitude of vibration, distance of sounding body.

(3) Musical tone - characteristics, intensity, pitch, quality and factors upon which each depends.

(4) Musical instruments - production of musical tones, change of pitch and change of intensity, various stringed and wind instruments, phonograph.

E. Light.

(1) (a) Nature of transmission of light - pinhole camera, shadows.

(b) Intensity of illumination, illuminating power, law of inverse squares, photometry, practical applications.

(2) Reflection of Light.

(a) Plane mirrors, laws of reflection, position and characteristics of images in inclined and parallel mirrors.

(b) Curved mirrors, e.g., convex, concave and parabolic: principal focus, real and virtual images, relative position and magnitude of object and image; practical applications.

(3) Refraction of Light

(a) Nature and cause of refraction; Laws of refraction; Index of refraction; refraction phenomena - plate glass prisms, lens; total reflection.

(b) Lenses - concave and convex - principal focus, focal length, power, conjugate foci, images.

(c) Applications, Luxfer prisms, magnifying glasses, spectacles, camera, projection lantern, microscope.

(4) Color.

(a) Production of the spectrum, complementary colors, rainbow.

(b) Color of objects; mixing paints.

N.B. The course in light should be mainly experimental drawings representing images with plane and curved mirrors, mirrors and lenses being omitted.

F. Electricity and Magnetism

(1) Magnetism

(a) Natural and artificial magnets, magnetic substances; polarity, Law of attraction and repulsion; Induction; Field of force, magnetic permeability, shielding.

(b) Earth's magnetism - Demonstration of Earth's polarity and inductive action; declination and inclination, compass.

(2) Current Electricity.

(a) Voltaic cell - construction, source of energy, local action, polarization, detection of current; a few common cells, construction, use, methods of preventing polarization and local action.

(b) Electric units - ampere, volt, ohm; Ohm's Law; grouping of cells.

(3) Chemical and Magnetic effects of the electric current.

(a) Chemical - electrolysis of water, electroplating.

(b) Magnetic -

(i) Magnetic field about a conductor; electromagnet; function of helix and core; conditions determining strength of electromagnets.

(ii) Practical applications of electromagnet - electric bell, telegraph instruments, lifting magnets, calvanometers.

(4) The induced Current.

Conditions for production of induced currents, direction of induced currents - Lenz' Law; alternating currents; easy illustrations.

Physics 2.

Introduction.

The course stresses the valuable contribution of applied mathematics to the development of Physical Science, and enables the student to grasp new possibilities in each through their intimate correlation.

Outline of Course

A. Measurements

Units of time, mass, length, area, volume, etc., and methods of measuring these quantities.

B. Motion.

(1) Definition - displacement - velocity - parallelogram of

velocities - resolution of displacements.

(2) Acceleration - uniform acceleration, acceleration due to gravity.

(3) Momentum - Relation of momentum to mass and velocity - change of momentum - relation of force and time - Newton's Second Law of Motion - transference and conservation of momentum.

C. Force.

(1) Gravity and absolute units of force - mass and weight - comparison of masses.

(2) Inertia - Newton's First Law.

(3) Action and Reaction - Newton's Third Law.

(4) Centrifugal and Centripetal forces - practical applications, e.g., Centrifuge, Bobcock's Milk Tester, Cream Separator.

(5) Composition and resolution of forces - parallelogram of forces, triangle of forces.

(6) Moment of a force - resultant of parallel forces - couple - equilibrium of a rigid body.

(7) Friction - sliding and rolling friction - coefficient of frictions - laws of friction.

(8) Centre of gravity - condition of equilibrium - three states of equilibrium.

(9) Gravitation - principle of universal gravitation.

D. Energy.

(1) Units of energy and power including heat, electrical and mechanical units.

(2) Law of conservation of energy - transformation of energy and relation of energy and power units, heat, electrical and mechanical.

(3) Power development and transmission - practical application - water powers and water wheels, turbines, steam engines, steam turbines, gasoline engines, wind-mills - transformation to electrical energy, transmission and use of electrical energy.

E. Machines.

Levers, pulley, wheel and axle, inclined plane, wedge, screw, differential pulley, differential wheel and axle, automobile transmission.

Mechanics of Fluids

A. Pressure of Fluids.

(1) Pressure of fluids at rest - pressure proportional to depth and specific gravity of liquid - pressure independent shape of containing vessel - pressure gauge - calculation of pressure on horizontal, vertical and inclined surfaces.

(2) Transmission of pressure - pressure transmitted equally and undiminished in all directions and at right angles to surfaces.

(3) Buoyancy - Archimedes' principle, density and specific gravity, definition of terms and methods of determining specific gravity of solids and liquids.

(4) Pressure of air - Torricelli's experiment - cistern barometer - determination of heights by barometer - buoyancy of gases.

B. Surface Tension.

Surface tension - laws of capillarity - practical applications.

C. The Flow of Liquids.

Torricelli's Law - rate of flow of a liquid - energy of a liquid in motion - Bernoulli's principle venturi water meter - practical applications - Jet pump, Bunsen's filter pump, atomizer.

D. Kinetic Theory of Gases.

Explaining Boyle's Law, Charles' Law, rate of diffusing of gases through porous walls, expansive pressure of gases - calculation of rate of motion of molecules of gases.

E. Machines.

Construction and operation and principles applied. Lift pump, force pump, hydraulic press; siphon, Geryk or oil air pump, mercury air pump, condensation vacuum pump, air compressors, air brakes, pneumatic caisson, pneumatic hammer and drill.

Outlines of Requirements 1959-60.

Science 10.

Following are suggestions with respect to course content for science 10 for the school year 1959-60. The prescribed text for grade X is Physical Sciences for Canadian High Schools. As this text does not contain sufficient chemistry to handle this course it is recommended that use be made of the grade XII chemistry text, Chemistry for Secondary Schools, Advanced Edition. For your convenience page references are given to these two texts. Students in grade X will be

expected to purchase the grade X text but not the grade XII text. It is recommended that the teacher have a copy of the grade XII chemistry text for handy reference. (Experimental work in this course should receive emphasis.)

Students should be able to master a minimum of 25 equations based on material covered in the course and found in the pages listed in the texts Physical Sciences for Canadian High Schools or Chemistry for Secondary Schools.

The presentation of the topic of valence should be approached from the structure of the atom which will give valence its true meaning.

Exercises at the end of each chapter in Physical Sciences for Canadian High Schools should be supplemented.

INTRODUCTION. SCIENCE AND HUMAN ACHIEVEMENT.

Chapters 1. Early Progress
2. Modern Developments

UNIT 1. THE NATURE OF THINGS

Chapters 3. Atoms and Molecules
4. Molecules in Motion
5. Air, an Important Mixture
6. Water, an Important Compound
7. Water for Machines

UNIT 3. TEMPERATURE AND HEAT

Chapters 13. What is Temperature?
14. What is Heat?
15. Expansion

16. How Heat Travels
17. Evaporation and Boiling.

UNIT 5. FIRE AND FUELS

Chapters 22. What is Fire?
23. Oxidation
24. Fires and Explosions

UNIT 7. ELECTRICITY

Chapters 35 What is Electricity?
36. Electric Currents

UNIT 9.

Chapters 44. What is Sound?
45. Sound Instruments
46. The Telegraph and Telephone (as far as but not including Vacuum Tubes).

UNIT 11. THE CHEMICAL NATURE OF THINGS

Chapters 53. Chemical Activity
54. The Shorthand of Chemistry
55. What are Ions?

Science 20

The following outline is intended for use in all schools during 1959-60.

The texts for the Chemistry-Physics course (Science 20) are as follows:

1. Basic Physics (Alberta Edition): Eubank, Ramsay, Richard.
2. Chemistry for Secondary Schools, Advanced Edition: Croal, et al. (Laboratory experiences should be provided:

Experiments in Laboratory Chemistry: Couke, Croal, Loudon (Copp Clark) Teacher's Reference.)

All students should be requested to buy these two texts.

A. PHYSICS SECTION (Basic Physics (Alberta Edition): Eubank, Ramsay, Rickard.)

1. Mechanics

Suggested time - 2 months.

Chapters 1. Introduction
2. Measurement
3. Density and Specific Gravity
4. Buoyancy
5. Force, Work and Power
6. Experiments on Mechanics

2. Light

Suggested time - 2 months.

Chapters 7. Nature and Propagation of Light
8. Photometry
9. Reflection of Light-Mirrors
10. Refraction of Light-Lenses.
11. Color
12. Optical Instruments
13. Experiments on Light.

Experimental work is to be considered an integral part of the course. Students should spend at least one day a week in the laboratory. All problems at the end of each chapter should be

done by the students.

B. CHEMISTRY SECTION

Suggested time - 4 months.

1. Solutions: Terms describing Solutions

2. Chemical Classification:

   Law of Conservation of Mass

   Law of Definite Proportion

   Law of Constant Composition

   Classification Table

   Summary of Mixtures, Solutions, Compounds.

3. The Gas Laws:

   Reason for Pressure

   Standard Normal Pressure

   Boyle's Law

   Determining the coefficient of expansion of a gas

   Absolute Temperature

   Charles' Law

   Standard Temperature

   Combination of Boyle's and Charles' Laws.

   (Pupils should have an understanding of how the two laws work together.)

4. Laws and Theories

   Rather than a formal presentation of this chapter as a unit it is intended that the information will be introduced as required by the class.

5. Symbols, Formulae and Equations

6. Valence

As an introduction to the formal presentation of the topic of valence it is suggested that the structure of the atom be presented to the class. Once this is mastered the matter of valence takes on its true meaning. It is also suggested that the stress be on electro-valence only and that the problem of covalence be left until Chemistry 30 except for a reference to the formation of gas molecules such as H_2, O_2, etc.

Valence and the electron theory.

Meaning of valence.

Elements with several valences.

Table of valences.

Using valence.

7. Naming Compounds

NOTE: It has been found that students who understand this chapter grasp more readily the rest of the high school chemistry and will build rather than memorize formulae and equations. Students should do all the exercises 1-26, pages 144-146.

8. Using Equations

Calculating relative weights.

Solving weight-weight problems.

Solving weight-volume problems.

Solving volume-volume problems.

NOTE: Those schools that followed the Experimental Course in Science 10 last year will have done considerable work in valence in Science 10. This will be reviewed this year and other work may be added to this year's Science 20. In the experimental course, Hydrogen and Nitrogen were omitted in Science 10 (Hydrogen pages 42-50 and Nitrogen pages 35-38). This may be added to the Science 20 course. If time permits Chapter 25 of the text, Calcium and Magnesium, page 259, may also be added to the Science 20 course.

Suggested time for further expansion of topics, review, examination, etc. - 2 months.

Chemistry 30 (1959-60)

1. Authorized Text-book: Chemistry for Secondary Schools (Advanced Edition) Croal et al.
2. Course Content: The course consists of chapters 10-15 (review) and chapters 16-33 (new material).

Chapters 10-15 have been included in order to provide for the necessary review of the fundamental mathematics of chemistry. It is suggested that not longer than four (4) weeks be used for this review.

It will be recalled that Chapters 1-10 inclusive have become teachers' reference material for Science 20.

Physics 30 (1959-60)

1. Authorized Text-book: Elementary Physics: Littler.

2. Course Content:

(a) The content selected from the text consists of materials on three topics: Mechanics, Heat and Electricity.

(b) The following portions of the text are used:

1. Mechanics: Chapters 1-11 inclusive.
2. Heat: Chapters 13-18 inclusive, and Chapter 21.
3. Electricity: Chapters 33, 34, 36 up to and including "Solenoid", 37, 38 and 39.

(c) In addition to the above, it will be very desirable to commence the course by teaching the Metric System of measurement.

The authorized text was selected because of its precise descriptive and quantitative treatments of the selected topics.

These qualities of precise statement and accurate calculation will become, it is hoped, specific objectives in the teaching of this course.

APPENDIX C.

PRESCRIBED LABORATORY EXERCISES

Physics 1. (1935-36)

No laboratory work was prescribed in Physics 1 in the year 1935-36. One note was found in the Outlines of Requirements which read:

N.B. - The course in light should be made as experimental as possible, but the use of drawings representing images with plane and curved mirrors and lenses will be found necessary for purposes of illustration.

Physics 2. (1935-36)

No laboratory exercises were prescribed.

Chemistry 1. (1935-36)

Prescribed laboratory manual - Cornish and Smith: A Laboratory Manual in Chemistry.

The problems listed below are taken from the authorized text. It is expected that the experiments listed at the bottom as suitable for students will actually be performed by them. All others should be demonstrated before the class by the teacher.

1. Experiments on Calcination, Sec. 5.
2. Experiments on Prep. and Properties of Oxygen.
3. Experiments on "Law of Conservation of Weight". Sec. 31.
4. Experiments on Test for water.
5. Experiments on Action of Metals on Water. Sec. 41.
6. Experiments on Prep. and Properties of Hydrogen.
7. Experiments on Synthesis of Water. Sec. 48.

8. Experiments on Reducing Action of Hydrogen. Sec. 48.
9. Experiments on Solutions. Sec. 57.
10. Experiments on Deliquescence and Efflorescence. Sec. 63-64.
11. Experiments on Prep. and Properties of Hydrogen Chloride.
12. Experiments on Test for Chlorides. Sec. 113.
13. Experiments on Prep. and Properties of Chlorine.
14. Experiments on Reducing Action of Carbon. Sec. 118.
15. Experiments on Prep. and Properties of CO_2. Sec. 120-122.
16. Experiments on Test for Carbonates.
17. Experiments on Prep. and Properties of CO. Sec. 125-126.
18. Experiments on Prep. and Properties of CH_4. Sec. 130.
19. Experiments on Prep. and Properties of C_2H_2. Sec. 131-132.
20. Experiments with Hard and Soft Water: Correction of Hard Water. Sec. 139.
21. Experiments on Prep. of Allotropic Forms of S. Sec. 148.
22. Experiments on Activity of S. Sec. 150.
23. Experiments on Prep. and Properties of H_2S. Sec. 156-158.
24. Experiments on Prep. and Properties of SO_2. Sec. 160-168.
25. Experiments on Test for Sulphites. Sec. 168.
26. Experiments on Properties of H_2SO_4. Sec. 171-173.
27. Experiments on Properties of SO_3. Sec. 162.
28. Experiments on Test for Sulphates. Sec. 174.
29. Experiments on Prep. of Salts. Sec. 181-182.
30. Experiments on Prep. of HNO_3. Sec. 187.
31. Experiments on Properties of HNO_3. Sec. 189.

32. Experiments on Heating Nitrates. Sec. 190.

34. Experiments on Prep. and Properties of N_2O. Sec. 192.

35. Experiments on Prep. and Properties of NO. Sec. 194.

36. Experiments on Prep. and Properties of NO_2. Sec. 193.

37. Experiments on Prep. and Properties of NH_3. Sec. 197-198.

42. Experiments on Prep. and Properties of H_2O_2. Suitable experiments for students; 1, 9, 10, 12, 14, 15, 16, 20, 21, 24, 25, 28, 29, 32, 33, 37.

Chemistry 2. (1935-36)

Prescribed laboratory manual - Littler: Laboratory Manual to accompany Book II.

The following exercises from the Manual comprise the practical work for the year:

(a) To be treated as demonstration experiments only - Exercises 14, 19, (No. 5 only), and 42.

(b) To be treated either as demonstration experiments or to be required of all pupils as the teacher may determine - Exercises 6, 27, and 39.

(c) To be required of all pupils - Exercises 8, 9, 10, 13, 15, 16, 17, 21, 22, 25, 32 (experiment 1 only), 33, 34, 35, 36, 37, 38, 40, 41, 43, 46, 50, 51, and 52.

It is felt that the above prescription should require roughly 30 periods in the laboratory, allowing two periods for Exercise 33 and four or five for Exercises 51 and 52. This does not include the time

required for demonstrations by the teacher.

Each teacher of Chemistry 2 will be required to certify before the 30th of June 1936, that his students performed the laboratory experiments outlined in the authorized Manual.

In the examination in Chemistry 2, eighty-five per cent of the marks will be based on the written examination; the other fifteen per cent, on the laboratory work of the student. In submitting their certified statements teachers will be required to give their estimate of the practical work of each student by assigning him a mark from the total allotted for this part of the course. This mark will be added to that received by the student in his written examination.

For the purpose of the laboratory work, experiments performed in groups of two will be considered as individual work.

Candidates will be required to pass on the Laboratory work as well as on the paper on Theory.

1. Each teacher of Chemistry 2 will be required to certify before the 30th of June 1936, that his students performed the laboratory experiments outlined in the authorized Manual.
2. 15% of final mark on lab. work assigned by teacher. (see p. 11)
3. Candidates will be required to pass on the Laboratory work as well as on the paper on Theory.

Prescribed Experiments:

1. Reversible Reactions
2. Ionization
3. Hydrolysis

4. Neutralization

5. Electrochemical Series

6. Hydrogen Fluoride (teacher demonstration)

7. Hydrogen Bromide and Bromine

8. Hydrogen Iodide and Iodine

9. Chlorides, Bromides and Iodides

10. Arsenic and some of its Compounds (teacher demonstration)

11. Sodium Hydroxide

12. Other Compounds of Sodium

13. Properties of Sodium Thiosulphate

14. Density of Oxygen and Percentage of Oxygen in Potassium Chlorate.

15. Some Compounds of Magnesium

16. Valency of Magnesium

17. Zinc and some of its Compounds.

18. Aluminum and some of its Compounds

19. Iron and some of its Compounds

20. Other Compounds of Iron

21. Copper and some of its Compounds

22. Silver and some of its Compounds

23. Halogen Compounds of Silver

24. Silver from a Coin

25. Oxides of Lead (teacher demonstration)

26. Other Compounds of Lead

27. Sugars

28. Flame Tests

29. Qualitative Analysis-Cations

30. Qualitative Analysis-Anions.

Science 10. (1959-60)

No experiments were prescribed. However this note appeared in the Course Outlines - Experimental work in this course should receive emphasis.

Science 10. (1959-60) (alternate)

Experimental work is to be considered an integral part of the course. Students should spend one day a week in the laboratory. The choice of experiments is left entirely with the teacher. Not all experiments can be covered therefore it is important to exercise care in the selection of those to be done.

(42 experiments in the Chemistry section and 33 experiments in the Physics section are outlined in the text-book - Introductory Chemistry and Physics.)

Science 20. (1959-60)

Laboratory experiences should be provided: Experiments in Laboratory Chemistry: Couke, Croal, Louden (Copp Clark). Teacher's Reference.

Experimental work is to be considered an integral part of the course. Students should spend at least one day a week in the laboratory.

Note concerning laboratory work: Some teachers have found difficulty in supplying laboratory exercises to cover the chemistry of Science 20. Source material for demonstrations as well as class

experiments in this section of the work may be found in Experiments in Laboratory Chemistry by Cooke, Croal, Louden, published by Copp Clark, Toronto.

In all cases as much experimental work as possible should be introduced. The text Experiments in Laboratory Chemistry will be of considerable help to the teacher in outlining the course. Problems involving percentage composition, weight to weight, weight to volume, and volume to volume relationships should be stressed. (35 experiments are outlined in Physics. No specific experiments are outlined in Chemistry.)

Chemistry 30. (1959-60)

Prescribed laboratory manual - Department of Education:

Laboratory Exercises in Chemistry 30.

The revised laboratory manual consists of twenty laboratory exercises, eleven of which include teacher demonstration material. Students will be expected to perform not fewer than fourteen laboratory exercises, including the obligatory exercises: 1, 2, 3, 4, 7, 13, 17, 18, 20, 23, 24.

1. Ionization
2. Acids, Bases, Salts
3. Neutralization
4. Hydrolysis
5. Reversible Reaction, Common Ion Effect, Efflorescence and Deliquescence.
6. Common Forms of Carbon, Destructive Distillation, Uses of Carbon, Carbon Dioxide, Fire Extinguisher, Carbon Monoxide.

7. Flame Tests, Flame structure, Combustion Products, Borax Bead Test, Cobalt Nitrate Test.
8. Allotropic Forms of Sulphur, Hydrogen, Sulphide, Sulphur Dioxide, Sulfuric Acid.
9. Crystal Structure, Electrolysis, Hydrogen Chloride Gas, Solvay Process.
10. Chlorine
11. Bromine and Hydrogen Bromide.
12. Iodine, Hydrogen, Iodide, Fluorine.
13. Chlorides, Bromides, Iodides.
14. Ammonia, Nitric Acid, Nitrates, Oxides of Nitrogen.
15. Calcium and Magnesium Compounds.
16. Metallurgy, Alloys.
17. The Activity Series.
18. Aluminum: Amphoterism, Test for Aluminum, Purification of Water, Mordant.
19. Iron: Hardness of Steel, Tests for Ferrous and Ferric Ions, Oxidation of Ferrous, Reduction of Ferric, Blueprints.
20. Copper: Copper and some of its Compounds, Electroplating, Tests for Copper.
21. Organic Compounds: Alcohols, Aldehydes, Acids, Esters, Ethers, Soaps, Polymer or Plastic, Rayon, Perfume.
22. Foods: Starch, Sugar, Fats and Oils, Proteins, Mineral Matter, Baking Soda, Baking Powder.

23. Anion Analysis.

24. Cation Analysis.

Physics 30. (1959-60)

Prescribed laboratory manual - Department of Education: Laboratory Exercises in physics 30.

(a) Experiments;

The revised Laboratory Exercises consist of twenty experiments, from which students are expected to perform not fewer than fourteen (14). The fourteen or more experiments may be selected according to the type and quantities of equipment available. Not more than two (2) of the listed experiments may be omitted from each of the three topics.

Each of Experiments 1-11 inclusive, consists of two parts. In each case, PART B is stated as a follow-up problem to accompany PART A.

PART B is provided as extra work for the better students; its use is optional and at the discretion of the teacher.

(b) Demonstration:

In addition to experiments, described in Laboratory Exercises, the text provides ample suggestions for demonstrations.

Mechanics:

1. Measurement.
2. Force, Mass and Acceleration.

3. The Simple Pendulum.
4. Machines.
5. Parallelogram of Forces.
6. Coefficient of Friction.
7. Boyle's Law.
8. Specific Gravity by Archimedes' Principle.

Heat:

9. Coefficient of Linear Expansion.
10. Coefficient of Expansion of Liquids.
11. Specific Heat of Solids.
12. Latent Heat of Fusion of Ice.
13. Latent Heat of Vaporization of Water.
14. Mechanical Equivalent of Heat.

Electricity:

15. Electrostatics.
16. Laws of Electrolysis.
17. Lead Accumulator.
18. Ohm's Law.
19. Wheatstone Bridge.
20. Electric Motors.

APPENDIX D

DEPARTMENTAL EXAMINATIONS

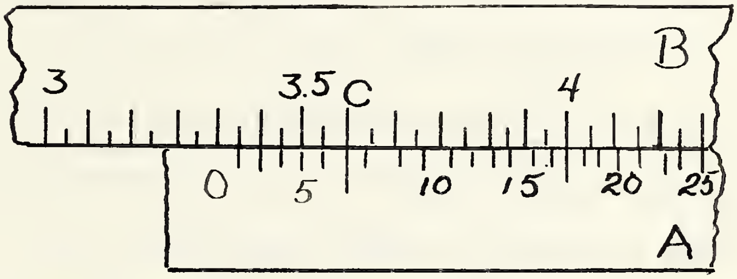
Physics 2 (1936)

Time - 2½ hours.

Note - Answer question 10 and any other six questions.

Values

1. (a) Give the correct reading on the scale shown below,
3 assuming that the vernier A and the main scale B
coincide at the point C.



(b) Discuss, using simple illustrations, the meaning of
4 each of the following terms, inertia, weight.

(c) A train starts from station A and moves with uniform
7 acceleration. After 1½ minutes it passes a point B
and 1 minute later another point C. If the distance
between B and C is 1200 yards, find the acceleration
of the train and the distance from A to B.

2. (a) Describe an experimental method for the determination
5 of g. the acceleration due to gravity. Indicate the
observations which are necessary and the method of
calculating the final value.

(b) A gun weighing 2400 pounds fires a 20 pound shell with a velocity of 1800 feet per second. Calculate

2 (1) the velocity of recoil of the gun.

3 (2) the average force in tons of the explosion, assuming that it occurred in 1/20 second.

4 (3) the average resisting force, in pounds, necessary to bring the recoiling gun to rest in a space of 5 feet.

3 3. (a) Distinguish the terms, energy and power. Define the C.G.S. unit by which each is measured.

4 (b) Deduce the formula K.E. = $mv^2/2$.

7 (c) A constant force of 400,000 dynes has acted upon a mass of 500 grams until the moment at which the mass possesses a kinetic energy of 25 joules. At what rate, in watts, is work being done at that moment?

7 4. (a) Describe an experimental method for the determination of the Mechanical Equivalent of Heat.

(b) A laboratory is equipped with a 200-watt projection lantern and an electric heater having a resistance of 27.5 ohms. If 110 volt current is used, calculate

(1) the total current when both the lantern and
2 heater are in use simultaneously.

(2) the time required for the heater to produce
5 4400 calories of heat. J = 4.2 joules per calorie.

5. (a) Show that the resultant of two forces P and Q, acting at
[illegible] a point and making an angle 0, less than 90°, with each
other, may be represented by

$$\sqrt{P^2 + Q^2 + 2PQ \cos \theta}$$

(b) A uniform rod AB, 6 feet long and weighing 6 pounds, is
10 suspended in a horizontal position by ropes attached to the ends and extending upwards and outwards. If the rope attached at A makes an angle of 30° and that at B an angle of 60° with the horizontal calculate the tension in each rope when a mass of 30 pounds is suspended from the rod at a point 2 feet from A.

6. (a) The sides AB and AC of a triangle, right-angled at A,
4 are respectively 18 inches and 12 inches long. Find the distance of the centre of gravity from C.

(b) Draw a diagram and explain the operation of the
6 differential wheel and axle.
Assume the necessary data and determine the mechanical advantage.

(c) Two men whose combined weight is 320 pounds have to
4 raise a safe weighing 1000 pounds to a second storey window. If friction is equivalent to a 250 pound weight,

show by diagram the simplest combination of pulleys that will just enable them to perform the task.

7. (a) A block of glass weighs 61.1 grams in air, 37.6
7 grams in water, and 36.4 grams in a salt solution.
Calculate the specific gravity of the glass and of
the salt solution.

(b) Make a diagram of a cistern barometer and label the
7 essential parts of the instrument. Discuss the
principle upon which it operates.

14 8. Discuss fully a method of determining the mass of the earth.

9. Discuss fully Boyle's Law with special reference to (1) its
14 experimental verification in the laboratory and (2) its
explanation on the basis of the kinetic theory of gases.

10. N.B. In the following short-answer questions, one only of
16 the three answers suggested is correct. Letter carefully
each section attempted, and upon your answer paper copy
only the correct word or phrase in each case.

(a) A freely falling body illustrates

(1) uniform acceleration,
(2) variable acceleration,
(3) negative acceleration

(b) A body released from an airplane moving horizontally requires (1) a shorter, (2) a longer, (3) an equal, period of time to reach the earth compared to the time taken by a body released from rest at the same height.

(c) If a balance with two equal arms is used to weigh a given mass, the reading of the balance at the equator will be (1) greater than, (2) equal to, (3) less than, the reading at the north pole.

(d) The formula $F = PV^2$ represents the value of the pressure of a moving fluid when it strikes a plane surface at right angles. In the F.P.S. system, the unit of pressure would be (1) the poundal, (2) the dyne, (3) the pound.

(e) The attraction F between two bodies of equal masses m, placed at a distance d from each other, is expressed by the formula (1) $F - K\ 2m/d$ (2) $F - K\ d/m^2$ (3) $F = K\ m^2/d^2$.

(f) A mass of mud is thrown from a rapidly revolving carriage wheel by (1) gravitational force, (2) centripetal force, (3) centrifugal force.

(g) A machine (1) creates, (2) transforms, (3) destroys, energy.

(h) An engine of one horse-power is capable of doing 550 foot-pounds of work in (1) one minute, (2) one second, (3) one hour.

(i) A cone lying on its side is in (1) neutral, (2) stable, (3) unstable, equilibrium.

(j) The coefficient of kinetic friction varies directly as

(1) the area of the surface in contact,

(2) the rate of motion,

(3) the pressure between the surfaces.

(k) The buoyant force exerted upon a body immersed in a fluid is equal to the weight of the fluid displaced. This is a statement of (1) Boyle's Law, (2) Archimedes' principle, (3) Pascal's law.

(l) The kilowatt-hour is a unit of (1) energy, (2) power, (3) force.

(m) A helium filled balloon floats in air because of (1) the difference in the densities of helium and air, (2) the pressure of the atmosphere, (3) the temperature of the atmosphere.

(n) When the volume of a given mass of gas is suddenly decreased there is (1) an increase in pressure and an increase in temperature, (2) only an increase in pressure, (3) an increase in temperature and a decrease in pressure.

(o) An air-pump can be successfully used to remove the air from a closed container because of the (1) buoyancy of air, (2) expansibility of air, (3) specific gravity of air.

(p) The resultant of two forces acting at a point (1) increases, (2) remains unaltered, (3) decreases, as the angle between the forces varies from 0° to 180°.

100

Chemistry 2 (1936).

Time - 2½ hours.

Note - Answer questions 1, 2 and 3, together with any other five questions. All calculations should be completed to one decimal place.

Atomic weights: C = 12; Cl - 35.5; H - 1; O - 16; Na = 23; S = 32.

Values

2 1. (a) State the Periodic Law.

8 (b) By reference to the physical and chemical properties of the elements and their hydroxides, show why lithium, sodium, potassium, rubidium and caesium are placed in the same family.

3 (c) Boron has an atomic weight of 11 and an atomic number of 5. Draw a diagram to show the structure of the boron atom.

2. (a) An unknown salt is dissolved in water. Definitely identify this salt, giving conclusions deduced from each of the following tests.

1 (1) The original solution changes blue litmus red.

3 (2) Hydrochloric acid is added to the original solution. No precipitate is formed.

2 (3) Hydrogen sulphide is passed into the solution obtained in (2). A black precipitate is obtained.

1 (4) The precipitate from (3) is not soluble in hot dilute nitric acid.

1 (5) Some of the original solution is evaporated to dryness, copper filings and a little sulphuric acid are added

to the dry salt, and the mixture is warmed. Reddish brown fumes are produced.

1 (6) Write the formula of the salt.

3 (b) Describe tests for identifying (1) potassium phosphate, (2) potassium sulphide.

2 3. (a) Using structural formulae to illustrate, distinguish between saturated and unsaturated hydro-carbons.

2 (b) Write an equation to indicate the formation of acetic acid from ethyl alcohol.

2 (c) Explain and give an example of isomerism.

4 (d) Describe, explaining the chemical reaction involved, the manufacture of soap.

4 4. (a) Write the chemical formulae for any four of the following substances: ferric sulphite, calcium iodate, plaster of Paris, lead acetate, haematite, potash alum.

6 (b) How many grams of sodium bicarbonate are required to produce 38 litres of carbon dioxide measured at 17°C. and 870 mm. pressure? Write the equation for this reaction.

5. (a) Anhydrous cupric chloride is yellow.

1 (1) Make a small quantity of a concentrated solution of cupric chloride in water. What is its color?

1 (2) Add water little by little (shaking after each addition) until a definite color change can be detected. What change in color occurs?

(3) Now add hydrochloric acid. What further change in color takes place? 1

5 (4) Using the ionization theory, account for the changes in color in this experiment.

4 (b) What volume of 1.25 normal sulphuric acid is required to neutralize 55 cc. of 0.84 normal sodium hydroxide? How may one know when neutralization is complete?

10 6. Write equations to show the reactions in the following:

(1) Hydrofluoric acid is used to etch glass.

(2) Formaldehyde is produced from methyl alcohol.

(3) The hydrolysis of copper sulphate.

(4) Silver bromide is dissolved in a solution of "hypo" (sodium thiosulphate).

(5) Carbon dioxide is absorbed by sodium peroxide.

4 7. (a) Indicate by equations how (1) temporary, (2) permanent hardness in water may be removed.

4 (b) Contrast the properties of ferrous and ferric salts.

2 (c) Give an important commercial use for each of any two of: zinc oxide, mercuric sulphide, arsenious oxide.

7 8. (a) The properties of steel may be varied by means of heat treatment and by the addition of other metals. Discuss these methods indicating in each case the special property which results.

3 (b) Explain the use of a mordant in dyeing cotton cloth. Give an example.

8 9. (a) Describe a process used to extract and refine copper from its sulphide ore.

2 (b) Name the components of two alloys of copper.

10. Lettering the subsections as indicated below, supply only the missing word or phrase in each case.

1 (a) The head of an ordinary match is composed of phosphorus sulphide, ______ and a little gum to hold it together.

1 (b) In descending the electrochemical series, the metals oxidize ______ rapidly.

1 (c) The elements on the left of the Periodic Table, beginning with Group 1, are strongly electro______.

1 (d) Many elements consist of more than one form differing from each other in atomic weight. Such forms are known as ______.

1 (e) Arsenic is known as a ______, that is, an element on the border line between metals and non-metals.

1 (f) Metals give rise to ______ oxides.

1 (g) ______ is the most malleable of all metals.

1 (h) A study of aluminium hydroxide leads to the conclusion that aluminium oxide can function either as a case or as an acidic oxide according to circumstances. Therefore it is said to be __________.

1 (i) An ester is a compound formed by replacing the hydrogen of an acid with ____________.

1 (j) Tartaric acid, having two replaceable hydrogen atoms, is known as a ________ acid.

10 11. Discuss the chemical industries of Alberta and the possibilities of their expansion in the future.

85

Physics 30 (1960).

Time - 3 hours.

Note - The total time allowed for this paper is three hours. Distribute this time to best advantage, reading the paper, answering the questions and reviewing the work already done. Do not spend too much time on any one question. Seventy-five minutes is suggested for the first 40 questions. Logarithm books will be supplied by the examiner.

Candidates will not be permitted to use slide rules.

In questions 1 to 40 spaces are provided for answers.

No work need be shown.

In problems 41 to 53 complete solutions must be shown.

Show all statements clearly and completely. The major portion of the marks is based on your knowledge and application of scientific principles. For g use either 980 cm./sec.^{2} or 32 ft./sec.^{2} as appropriate.

Questions 1 to 40 carry values of 2 marks each.

Write the correct answer along with the proper units, in the spaces provided.

1. The speedometer of a uniformly accelerated car indicates a speed of 20 m.p.h. Find the average velocity. --------------
2. Find the acceleration of the car in problem 1. --------------
3. In a space-time diagram, the slope of the graphs represents ---------------

4. A motor car is being driven at 40 m.p.h. in a direction due south and a west wind is blowing at 20 m.p.h. Find the apparent direction of the wind to the driver. ----------

5. Find the apparent resultant velocity of the wind to the driver mentioned in problem 4. ----------

6. A body falls from rest for 2 seconds. How far does it fall? ----------

7. What acceleration is produced in a mass of 10 lb. by a force of 2 lb. wt.? -----------

8. What is the momentum of a mass of 4 lb. moving with a velocity of 10 ft./sec.? -----------

9. A mass of 10 lb. has its velocity increased from 20 ft./sec. to 40 ft./sec. in 5 seconds. Find the impulse of the force. -----------

10. What is the kinetic energy of a mass of 4 lb. moving with a velocity of 10 ft./sec.? ------------

11. A force of 10 lb. wt. acts at right angles to a crank AB 6 inches long. If the force acts at A, find the moment of the force about B. ------------

12. A force of 20 lb. wt. applied horizontally to a block of stone of mass 100 lb. resting on a level surface just moves the block. What is the coefficient of friction between the stone and the level surface? -------------

13. A stone weighs 40 gm. wt. in air, 20 gm. wt. in water and 24 gm. wt. in alcohol. Find the specific gravity of alcohol. ----------

14. A rectangular tank 80 cm. long, 40 cm. wide and 25 cm. deep is full of water. Calculate the thrust on the bottom in kilogram wt. ----------

15. The volume of a given mass of gas is 99 c.c. at S.T.P. Find its volume at 20°C. and 700 mm. of mercury pressure. Answer to nearest c.c. ----------

16. A brass rod is 1000 cm. long at 20°C. Find its expansion if the temperature is raised to 120°C. (Coef. of linear expansion is o.000020/C°.) ----------

17. Ethyl alcohol is kept in a glass container. The coefficient of linear expansion of glass is 0.00004/C°. The coefficient of absolute expansion of alcohol is 0.001110/C°. Find the coefficient of apparent expansion of alcohol in a glass. ----------

18. The volume of a given mass of gas is 273 c.c. at 0oC. Find its volume at -10°C. ----------

19. 250 calories are supplied to 5 gm. of water at 17oC. Find the resulting temperature. ----------

20. Find the thermal capacity of an aluminum calorimeter of mass 100 gm. (Sp. heat of aluminum is 0.217). ----------

21. One B.T.U. = (?) calories. ----------

22. 12 gm. of steam are blown into a large block of ice at 0°C. Assuming no heat losses, find the maximum number of grams of ice that could be melted. ----------

23. What minimum weight of water at 100°C. must be poured on a block of ice at 0°C. weighing 200 gm. wt. in order to melt it? ----------

24. How much ice at 0°C. must be mixed with 20 gm. of steam at 100°C. to produce a resulting temperature of 40°C.? ----------

25. How many ft. lb. wt. of work must be done to produce enough heat to raise the temperature of 20 lb. of water from 20°C. to 30°C.? ----------

26. Calculate the force between two like charges 2 and 10 units, 4 cm. apart in air. ----------

27. Two point charges of +50 and +98 units are placed 12 cm. apart. What is the magnitude of the electric field at a point on the line joining them, distant 2 cm. from the greater charge? ----------

28. How much work is done in transferring a unit positive charge from a point of potential 5 units to one of potential 15 units? ----------

29. The number of grams of an element liberated by one coulomb is known as the (?) of that element. ----------

30. The atomic weight of copper is 63. Its valence is 2. Find its chemical equivalent. ----------

31. A current of c amperes is passed for t seconds through an electrolyte, causing an element of electrochemical equivalent of z to be liberated. Find the mass of the element liberated. ----------

32. A current of 0.3 amp. is passing through a 60-watt lamp. Calculate the potential difference across the lamp filament. ----------

33.

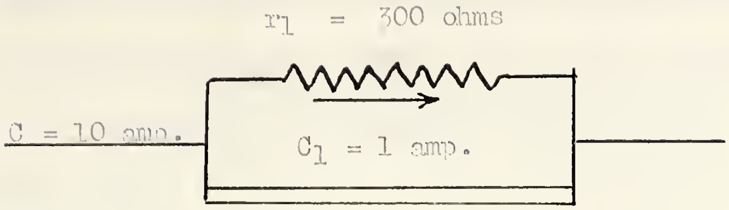
When a current is passed through a coil of wire, a magnetic field is set up as shown in diagram. What is the direction of the flow of electrons, A or B? ----------

34. If an electric lamp of resistance 500 ohms requires a current of 0.2 amp., what E.M.F. is required to light it? ----------

35. What total current will pass through two resistances of 1 ohm and 3 ohms connected in parallel when a potential difference of 3 volts is applied? ----------

36. How much heat is generated in 5 min. when a current at 2.0 amp. flows through a resistance of 10 ohms? ----------

37.



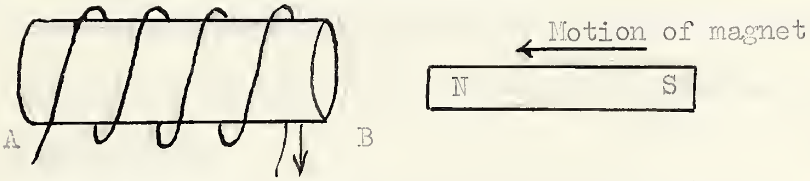
C_2 = 9 amp.

r_2 = ?

You wish to shunt 9 amp. of current by connecting the resistance r_2 in parallel with r_1 which has a resistance of 300 ohms. Find the resistance of the shunt. ----------

38. Three cells, each having an E.M.F. of 2 volts and an internal resistance of 0.6 ohm are connected in parallel. If this battery of three cells is connected to an external resistance of 4.8 ohms, find the current through the resistance. ----------

39.



A bar magnet is pushed into a coil as indicated inducing an E.M.F. in the coil. Which will be the direction of the electron flow, A or B? ----------

40. The resistance of the armature of an electric motor is 20 ohms. When run by a 120 volt source, it produces a back E.M.F. of 80 volts. Find the current. ----------

For problems 41 to 53 write out clear statements in

logical order and show the necessary calculations.

41. A stone is thrown from ground level with a velocity of 48 ft. per sec. at an angle of 30° with the horizontal.

3 (a) Draw a vector diagram showing the resolution of initial velocities.

4 (b) Find the time of the stone in the air.

2 (c) Find the maximum height of the stone in the air.

4 (d) At what distance from the starting point does the stone strike the ground.

42. A 2 ton truck is moving horizontally at 60 m.p.h. What steady force will stop it in

4 (a) half a minute?

4 (b) half a mile?

43. Calculate the work done in raising a block of iron, immersed in

6 water from a depth of 3 meters to a depth of 1 meter below the surface, if the mass of the block is 2 kilograms and its specific gravity is 8.

44. A picture of mass 10 lb. is hung by a wire which passes over a nail. The two parts of the wire make an angle of 60° with each other. Find the tension in the wire.

3 (a) Diagram of forces.

3 (b) Solution.

45. A tank 5 ft. long, 2 ft. wide and 4 ft. high is full of oil of specific gravity 0.9.

(Neglect air pressure. Density of water = $62.5 \frac{\text{lb.}}{\text{cu.ft.}}$
Calculate:

2 (a) The thrust on the bottom in lb. wt.

2 (b) The pressure at a point on the bottom in lb.wt. per sq. ft.

5 (c) The thrust on one of the smaller sides.

46. 200 gm. of copper at a temperature of 100°C. are dropped into a calorimeter containing 140 gm. of water at 15°C. The maximum temperature reached by the calorimeter and its contents after stirring is 25°C. Calculate the water equivalent of the calorimeter. (Specific heat of copper = 0.10).

47. A copper calorimeter weighing 24 gm. contains 100 gm. of water at 19.5°C., 12.8 gm. of dry ice at 0°C. are added and the temperature falls to 8.5°C. Calculate the latent heat of ice. (Specific heat of copper - 0.10) 8

48. One cu. cm. of mercury at 20°C. has a mass of 13.55 gm. What will be the mass of 1 c.c. of mercury at 100°C.? 6
(Coefficient of volume expansion of mercury = 0.00018/C°
(Correct answer to nearest one hundredth.)

49. A current of 5 amp. flows through a wire of resistance 10 ohms for 2 min. If the heat produced is supplied to 100 gm. of water, through how many degrees will the temperature be raised? 5

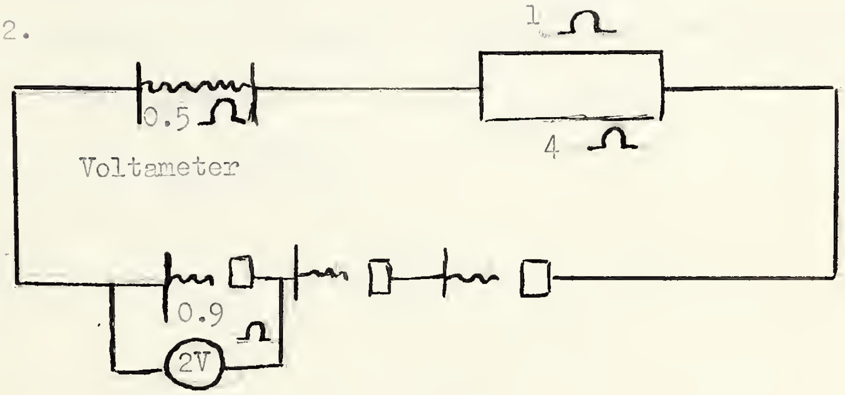
50. A motor takes $\frac{1}{2}$ amp. from a 4-volt accumulator when the motor is running freely, but the current rises to 2 amp. when the armature of the motor is brought to rest.

2 (a) find the resistance of the motor.

4 (b) find the back E.M.F. produced when the motor is running freely.

6 51. An accumulator of E.M.F. 4 volts sends a current of 10 amp. through a lamp. What is the potential difference across the lamp if the wires through which the current is taken to the lamp have each a resistance of $\frac{1}{100}$ ohm, and the internal resistance of the accumulator is $\frac{1}{40}$ ohm?

52.



An electric circuit consists of a battery of three cells in series (each of which has an E.M.F. of 2 volts and a resistance of 0.9 ohm), a copper sulphate voltameter of 0.5 ohm resistance, and a pair of wires in parallel (one having a resistance of 1 ohm and the other one of 4 ohms).

Find

3 (a) the total or combined resistance

2 (b) the strength of the current passing through the voltameter

2 (c) the strength of the current passing through the 4-ohm wire.

2 (d) the potential difference at the terminals of the voltameter

2 (e) the electrical energy expended per second in the voltameter.

53. Describe any instrument you have used for measuring or detecting currents. Draw a simple diagram. Explain its action and state for what purpose it is used.

3 (a) Diagram;

5 (b) Explanation:

Chemistry 30 (1960).

Time - 3 hours.

Note - The total time allowed for this paper is three hours.

Distribute this time to best advantage, reading the paper, answering the questions and reviewing the work already done. Do not spend too much time on any one question.

Log tables supplied by the Department of Education may be used.

N.B. - Candidates are not permitted to use Slide Rules.

Rough work may be done in pencil; finished work except diagrams should be done in blue or black ink.

In problems, work must be shown.

Carry calculations to one decimal place.

Indicate units.

Do not write your name on the booklet.

DO NOT FOLD THE BOOKLET.

Atomic Weights

C ---- 12   H ---- 1   Mg ---- 24   S ---- 32   Al ---- 27   O ---- 16.

30 1. Complete the following statements:

(a) The name of $K_4Fe(CN)_6$ is ------

(b) It is used to test for ------

(c) C_4H_{10} is called ------

(d) It belongs to a series called ------

(e) A mixture of slaked lime and cupric sulphate is called ------

(f) The color that strontium salts impart to a colorless flame is ------

(g) Glass is frequently etched with ------

(h) A salt used to sensitize photographic film is ------

(i) The product formed by the reaction of an alcohol and an acid is known as ------

(j) The process called nitriding is used for the purpose of ------

(k) The alloy Invar contains 36% ------

(l) The atomic weight of an element is 27. There are 14 neutrons. The atomic number is ------

(m) The number of rings or shells in the atom above is ------

(n) The change in the number of electrons of sulphur when it forms a sulphide is a ------

(o) The name of a metal whose hydroxide is amphoteric is ------

30 2. Place the number of the correct answer in the brackets at the right.

(a) One Litre of acetylene gas (C_2H_2) at STP weighs (a)

(1) 1.16 grams
(2) 2.6 grams
(3) 26 grams
(4) 44.8 grams.

(b)	How many grams of AL$(OH)_3$ are in a litre of a normal solution?	(b)	(1) 39 grams (2) 78 grams (3) 26 grams (4) 156 grams ----------
(c)	The volume of 1.2N sulphuric acid required to neutralize 300 c.c. of 0.2N potassium hydroxide solution is	(c)	(1) 50 c.c. (2) 150 c.c. (3) 300 c.c. (4) 1200 c.c. ----------
(d)	The molecular weight of Epsom salt ($MgSO_4 \cdot 7\ H_2O$) is	(d)	(1) 150 (2) 246 (3) 138 (4) 120 ----------
(e)	The percentage of hydrogen in acetic acid ($HC_2H_3O_2$) is	(e)	(1) 1.66 (2) 66.6 (3) 6.66 (4) 5 ----------
(f)	The characteristic group common to all aldehydes is	(f)	(1) -OH (2) -O- (3) -CHO (4) -COOH ----------
(g)	The formula for hypophosphorous acid is	(g)	(1) H_3PO (2) H_3PO_2 (3) HPO_3 (4) H_3PO_3 ----------
(h)	Magnetite is composed largely of	(h)	(1) Fe_2O_3 (2) FeS (3) $FeSiO_3$ (4) Fe_3O_4 ----------

(i) An example of an acid salt is

(i) (1) $HC_2H_3O_2$
(2) $Ca(HCO_3)_2$
(3) Na_2CO_3
(4) H_2S

(j) An example of a mixture of hydrocarbons is

(j) (1) ethyl alcohol
(2) benezene
(3) gasoline
(4) glycerol

(k) An example of a basic anhydride is

(k) (1) sulphur dioxide
(2) calcium oxide
(3) phosphorus trioxide
(4) sodium hydroxide

(l) Fluorine was discovered by

(l) (1) Scheele
(2) Courtois
(3) Arrhenius
(4) Moissan

(m) The color of ferrous compounds is usually

(m) (1) reddish brown
(2) pale blue
(3) pale green
(4) orange

(n) Cl^- is an ion of chlorine. It is an atom that has

(n) (1) lost an electron
(2) lost a proton
(3) gained a proton
(4) gained an electron

(o) When CO_2 comes in contact with moist litmus paper the color will be

(o) (1) red
(2) blue
(3) bleached
(4) purple

----

15 3. Fill in the spaces.

	COLOR	FORMULA	ONE USE
caustic soda			
hematite			
ruby			
potassium permanganate			
manganese dioxide			

10 4. In the bracket beside column 11, place the number of the material in column 1 that matches.

Column 1

(1) phosgene
(2) potassium bromide
(3) alum
(4) ammonium hydroxide
(5) sodium carbonate decahydrate
(6) carbon dioxide
(7) potassium chlorate
(8) concentrated nitric acid

Column 11

(a) A strong base ----------
(b) Washing soda ----------
(c) A poisonous gas ---------
(d) Good oxidizing agent ----------
(e) A sedative ----------
(f) A reducing agent --------
(g) A mordant ----------
(h) Makes Plaster of Paris ----------

(9) potassium chloride	(i) A commercial fertilizer --------
(10) gypsum	
(11) glycerine	(j) Reacts with copper --------
(12) hydrogen	
(13) calcium silicate	
(14) naphthalene	
(15) lye	

5 5. Name these compounds:

(a) $C_{10}H_{16}$ ----------

(b) $Ca_3(PO_2)_2$ ----------

(c) $C_3H_5(OH)_3$ ----------

(d) $NaClO$ ----------

(e) $Ca(HSO_3)_2$ ----------

5 6. Write formulae for the following:

(a) Formic acid ----------

(b) Formaldehyde ----------

(c) Calcium carbide ----------

(d) Ammonium ion ----------

(e) Magnesium nitride ----------

10 7. Write balanced equations for the following:

(a) Methyl alcohol is oxidized to formaldehyde and water.

(b) Steam is passed over hot iron filings.

(c) Chlorine is passed into caustic soda.

(d) The laboratory preparation of bromine.

(e) The complete combustion of hydrogen sulphide.

6. 8. Write Ionic equations for the following:

(a) Phosphoric acid ionizes.

(b) Chlorine is passed through a solution of potassium bromide.

(c) The action of copper in silver nitrate.

2 9. In 8 (b) above

(a) Which element is reduced?

(b) Why?

7 10. The nucleus of an atom contains 15 protons and 16 neutrons.

(a) What is its atomic number?

(b) What is its atomic weight?

(c) In which group of the periodic table would you find it?

(d) In which period or series?

(e) Is it more active or less active than fluorine?

(f) Is it metallic or nonmetallic?

(g) If its symbol is R, write the formula of its oxide.

IN ALL PROBLEMS, WORK SHOULD BE SHOWN:

3 11. The percentage of hydrogen in ethylene glycol

$C_2H_4(OH)_2$ is

12. The following equation represents the incomplete combustion of acetylene in air.

$$2C_2H_2 + 2O_2 \longrightarrow CO_2 + 2H_2O + 3C$$

If 546 litres of CO_2 at S.T.P. are produced

4 (a) What volume of acetylene is required?

6 (b) If the temperature and pressure were changed to minus 23° Centigrade and 500 mm., what would this volume of CO_2 become?

4 (c) What weight of carbon would be produced?

2 (d) If sufficient oxygen is supplied, complete combustion of acetylene takes place. Write the equation for this reaction.

13. A gaseous compound is composed of 82.75% carbon and 17.25% hydrogen. 500 c.c. of gas at S.T.P. weigh 1.30 grams.

5 (a) What is its simple formula?

3 (b) What is its true molecular weight?

2 (c) What is the true formula?

14 14. Write a careful, clear paragraph on the production of steel by the open hearth method. Refer to such things as structure, raw materials, heat, etc. (No marks given for equations or a diagram).

7 15. (a) Write a brief account of the electrolytic refining of copper, including equations.

(b) Why is this step necessary?

(c) Two by-products of this step are __________ and _______

8 16. State four uses of sulphur dioxide and indicate the property of the gas shown in each case.

(a) Use ----------

Property ----------

(b) Use ----------

Property ----------

(c) Use ----------

Property ----------

(d) Use ----------

Property ----------

10 17. By using equations and referring to the movement of ions, describe the electrolysis of a common salt (naCl) solution.

8 18. (a) Describe an experiment to show that aluminum hydroxide acts as a mordant. Include an equation.

(b) Draw a diagram of the Hall cell for the production of aluminum. Label all parts and materials.

19. A test tube containing hydrogen chloride gas and fitted with a one hole rubber stopper in which is a short piece of glass tubing open at both ends, is inverted and the tubing immersed in a glass of water.

2 (a) What do you observe?

3 (b) Explain the observation

1 (c) If the water contained some blue litmus, what change, if any, would you notice?

1 (d) Why?

10 20. Give the formula and use of each of the following compounds.

Compound	Formula	Use
(a) benzene	--------	--------
(b) ethyl alcohol	--------	--------

	Compound	Formula	Use
(c)	a freon	--------	--------
(d)	glucose	-------- -	--------
(e)	ethyl acetate	--------	--------

21. Draw structural formulae of

8 (a) (1) Propane (2) Glycine

(3) Ethylene (4) Iso-butane

2 (b) Which is the most reactive compound?

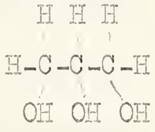
2 (c) Why?

3 (d) Define isomerism.

22. Classify the following as to group of organics.

Give the chemical name of each.

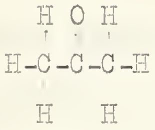
2 (a)



Group --------

Name --------

2 (b)

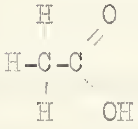


$$\begin{array}{ccccc} & H & O & H & \\ H- & C- & C- & C & -H \\ & H & & H & \end{array}$$

Group --------

Name --------

2 (c)



Name --------

Group --------

2 (d) $H_5C_2 - O - C_2H_5$

Name --------

Group --------

8 23. Describe the tests you would use to prove that a certain food is

(a) a starch

(b) a simple sugar

(c) a fat

(d) a protein

3 24. (a) Suppose you were given strong solutions of (1) sodium chloride, (2) sodium bromide and (3) sodium iodide. To each you added a solution of silver nitrate. What would you observe in (1), (2) and (3)?

(1) --------

(2) --------

(3) --------

2 (b) Give the equation of the reaction of the bromide and silver nitrate.

2 (c) After the reaction of the chloride and silver nitrate some ammonium hydroxide was added in excess. What would you observe?

2 (d) After the reaction of the bromide and silver nitrate the precipitate was exposed to sunlight. What would you observe?

2 25. (a) In your anion analysis some dilute HNO_3 is added to a solution. A sharp smelling gas evolves which turns some K_2CrO_4 solution green. Conclusion is ----------

2 (b) If the gas given off turns lead acetate black, your conclusion is -----------

3 26. (a) In your cation analysis some dilute HCl is added to a solution. Nothing happens.

Conclusion ----------

2 (b) H_2S is passed through the acidified solution from (a). A black precipitate forms which does not dissolve in boiling HNO_3.

Conclusion --------.

(c) Some of the original solution is subjected to a flame test.

2 (1) An orange red color appears.

Conclusion ----------

2 (2) An apple green color appears.

Conclusion.

B29795